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Lectures
On Chemistry
Containing

1.st The History of Chemistry
2.d An Introduction
3.d The Objects of Chemistry
4.th The Chemical History
of Bodies, and the
5.th Operations of Chemistry

History of Chymistry.

Chemistry, according to the modern acceptation of the word, is a very useful & extensive branch of natural philosophy.

The first author with whom this word is found is Plutarch who lived under the Emperors Domitian Nerva & Trajan. According to him the word signifies black. Others will have it originally denote secret or occult & derive it from the Hebrew Chaman or Haman, to hide. The first time the word Chemia or chemistry occurs as denoting the art we are speaking of is in a greek manuscript of Zozimus the Panopolitan preserved in the Kings library at Paris. This Zozimus lived under the younger Theodosius about 400 years after the christian æra, or beginning of the fifth Century.

*Genesis IV, 22

** Genesis 9, 20, 21.

From the etimology of the word we proceed to the history of the science itself. Some from a false opinion that our veneration for any art ought to be proportioned to its Antiquity, have attempted to prove it to be very ancient; some have gone so far as to pretend it was known even to the antideluvians. & it is apparent from holy writ that Tubal=Cain the 6th in descent from Adam was "an instructor of every artificer "in brass & Iron."* now as the assaying & working of metals is a branch of chemistry it is evident that ev for in those early ages they had some knowlege of this art. Again immediately after the flood we find Noah made wine* & was thereby intoxicated which is also a chemical process. But these instances in no wise prove that these people had any knowlege of chemistry

* This Ninus is said to have founded the Assyrian Empire & 20 years before the building of Rome.

× 6 4 & 8

as a science, nor indeed did it exist then or for many ages after.

Borrichius & Conringius have warmly disputed about the antiquity of chemistry. The former asserts that it was invented by the famous Egyptian philosopher Hermes Trismegistus who lived A. M. 2076 in the reign of Ninus* after Moses, he being accounted author of the hermetic philosophy wc pretends to explain all the phenomena in nature by three chemical principles salt sulphur & mercury ×. but as we have no authentic evidence of it, & as the doctrine of first principles is of more modern date, & took its rise among the greek philosophers, it is probable the hermetic philosophy was an invention of more modern date, & perhaps of grecian extract. The Cophtics or antient egyptians were

remarkable for their learning & knowlege in particular arts, especially embalming, w.ᶜʰ they carried to the greatest perfection of any people in the world, as their mummies, which for many ages rem.ᵈ uncorrupted & uninjured sufficiently prove. As their country was so fertile as to be esteemed the granery of the world they were consequently rich & popular, carried on an extensive trade with the Phoenicians, Syrians & Greeks, and no doubt were acquainted with the arts of manufacturing metals, and other substances for domestic use & ornament, as well as commerce & grandeur. So renown'd were they for learning in the days of moses that it's said to his praise that he was learn'd in all the wisdom of the Egyptians. And that they were well skill'd in metallurgy is further evident in the formation of the

× The celebrated German chemist Dr. Stahl has wrote a curious treatise entitled De vitulo aureo, in which he supposes Moses made use of Hepar Sulphuris as a solvent to render the golden calf soluble in water; a medium said to be the discovery of modern chemists.

golden calf by Aaron, but particularly the destroying it by Moses in so nice a manner as to render it miscible with water,ˣ a process very curious & discovers great skill in Chemistry, &c. he could only learn among the Egyptians where he had lived. But notwithstanding all the learning opulence & elegance of the Egyptians, they appear to have been utterly ignorant of chemistry as a science

Let us next look among the Greeks. This nation being frequently under the necessity of resorting to Egypt in times of scarcity, & being struck with surprise at their plenty, grandeur, ingenuity, & civil polity, became ambitious of imitating them, & being themselves ignorant, transported among other things the arts & sciences of Egypt into their

× The Egyptians in the time of Moses likewise transplanted colonies into Greece & founded the 12 villages of Attica of wh. was composed the Kingdom of Athens renowned for its number of eloquent orators and philosophers

native country, & afterwards greatly improved them, by their own assiduity, particularly the polite arts as logic, rhetoric, poetry, ethics[*] &c: but as the Egyptians had no scientific knowlege of chemistry, so neither do we find that the Greeks ever made any improvements therein. Most of the greek philosophers choosing rather to indulge their luxuriant fancies in speculative refinements and nice spun theories, than submit to the toil & perplexity of facts and experiments. Nor is it to be at all wondered at, that, even in matters of speculation, to w.^ch they were so much addicted, they so greatly dis:agreed, since they differd in sentiment as to what were the first principles of w.^ch all bodies are composed; some as

Metapontinus & Ephesius of Fire, others as Lampsacenus of air, others as Thales of water. Pereciydes of earth. Aristotle of all four together, whose system has been embraced by many. Others of Spirit water, bile, & black bile. Whilst others suppose all bodies to be composed of atoms variously combined. This atomic or corpuscular philosophy is the same with the phoenician and mosaical philosophy, & the most ancient of any. Descartes, Malbranche Bacon, Boyle, Newton Bentley and Clarke have embraced it, & it is now the prevailing doctrine

Since little of chemistry is to be found among the Greeks let us pass into Italy & examine the Romans. They being a fierce & warlike people fond of nothing but victory & martial enterprizes, paid little regard to the more polite arts

and sciences, till about 400 years after the building of Rome, when, having conquered the nations around, luxury & effeminacy, the consequences of peace & plenty, began to prevail; at which time also, many mechanic arts, which are of the cheapest kind, were introduced as necessary in this more polished period, such as utensils of every kind for use & beauty, soap, glass, earthen, tile &c

As the Greeks received their learning from the Egyptians, the Romans in return rec^d. theirs from the greeks. The first who wrote on philosophy among the latter was Lucretius who followed the opinion of Epicurus & Empedocles: he wrote 6 books de rerum naturâ.

Having travelled among the Egypti:ans Greeks & Romans & found that

chemistry as an art was unknown to them. Let us once more take a Journey into Africa & pass among the Arabians an ignorant & barbarous people till about the 6th century when having conquered Egypt, wch from the remarkable encouragement & patronage of learning by the successors to Alexander the great, particularly by Ptolemy Philadelphus, who invited all the famed men of his time to him, & collected a vast library, was now become very renowned for learning, & being subdued by the Saracens in 640 the Greek writings fell into their hands, which they translated & commented upon, particularly such as related to physic, & were the first that introduced pharmaceutic chemistry into medicine as appears evident 1st from the ancient chymists in Europe reciting to Geber & Rhazes as the oldest chemists; had there

been any before them they doubtless would have known it, especially among the Greeks. 2.d From their being the first that introduced any substance chemically prepared into medicine. 3.d From their discovery of new bodies as Nitre, and 4.th From their writings themselves in which many chemical processes are fairly described.

Before we proceed any further it will be proper for us to divide chemistry into three parts according as they took their rise at different times, viz Alchemy, medical or pharmaceutic, and philosophic chemistry

Of Alchemistry

By this we would be understood that occult science as it's generally termed w.c pretends to transmute metals. There are many books wrote upon it, some pretended to be the works of the ancient

× The human mind neglected uncultivated & depressed, sunk into the most profound ignorance. Europe did not produce, during four centuries, one author who merits to be read, either on account of the elegance of his compositions, or the justness and novelty of his sentiments.

Robertson.

Greeks others of the Egyptians, but it is very evident they were mostly wrote about the 12th 13th & 14th centuries during that dark & ignorant period after the declention of the roman Empire when the Goths & Vandals, those barbarous nations, had over run all Europe & learning shared the same fate with their cities & became buried in the lethean grove ✝

Alchemistry undoubtedly originated among the Arabs as appears from the particle Al- prefixed to the greek word Χυμια which denotes in their language our together with many other words wc are of arabian extract as alkohol, alkali, alkahest &c:

Notwithstanding all that has been wrote on this subject consists of idle enigmatic stories unworthy the perusal of any man, yet they have been of

service to chemistry, for others vainly endeavoring to discover the philosophers stone so celebrated by the alchemists for converting other metals into Gold have accidentally discovered many other things greatly to the advantage of this science. The pretended art of transmuting metals is now treated as it justly deserves with contempt & ridicule by the wisest of men.

Pharmaceutic chemistry

Let us now proceed to the history of pharmacy & the discoveries & improvem^ts: that have been made therein.

After the discoveries of medicines every thing was crouded into the materia medica without any order or regularity & was greatly encreased by the scholars of Hippocrates & in the school of Alexandria. Some

of their compositions tho' a disgrace to medicine have ever since been retained as the Theriaca, mithridate &c: for more of which see Scribonius Largus.

Galen & the later Greek & Roman physicians being ignorant of chemistry, pharmacy continued the same till about the 12th century when Rhazes introduced the chemical preparation of medicines & the Galenic pharmacy be-gan to decline & the bulk of formulæ to be lessened by extracting the active principles of medicines instead of using the whole in substance

In 1453 Constantinople was taken by the Turks. One would reasonably think learning must have suffered thereby, but it proved on the contrary a happy means of diffusing it in a remarkable manner thro' all the western parts of Europe, for

× Towards the beginning of the 12th century we discern the first symptoms of the human mind awakening from that lethargy in wc. it had long been sunk, & observe it turning with curiosity & attention towards the cultivation of literature & science

Its first efforts however were extremely ill directed. The powers of imagination attain some degree of vigour before the intellectual faculties are much exercised in speculative or abstract disquisition. Men are poets before they are philosophers. They feel with sensibility & describe with force, when they have made but little progress in investigation or reasoning. The age of Homer & of Hesiod long preceeded that of Thales or of Socrates. But, unhappily for literature, our ancestors deviating from this course wc. nature points out, plunged at once into the depths of abstruse & metaphysical enquiry, & wasted the force of their genius in speculations as unavailing as they were difficult.

many of the Greeks retiring into Italy carried the true greek copies with them, before unknown in those parts of Europe, except what was translated from the Arabic. × Learning now beginning to put on a more favorable aspect, some men of the brightest geniuses, seeing the bad state of Philosophy, boldly ventured to try their utmost for its improvement, which with the circumstance above mentioned set learning again on a respectable footing. Soon after app.^d a new disease in Europe, brought from America, called the Lues venerea

Paracelsus rejecting the system of Galen introduced a chemical one of his own, he was born in 1493, his father was a physician inclined to the sect of the chemists in w.^c he brought up his son. In his travels he became acquainted with

Opium Antimony & Mercury, with w:^h
he set out to practice & was made some
time after professor at Basil in which
he did not long continue, being soon
obliged to quit it. Afterwards offending
the magistrates he was banished Switzer:
:land, and, after travelling up & down
for some time, he died in 1543. He
wrote on Alchemy Palmistry & magic.
The chemists or followers of Paracelsus
were opposed by the Galenists; the latter
continuing for 1300 years till the time
of Crato who united the chemical and
galenical pharmacy together, and in
that state it has remained ever since.
The Galenists in England did not embrace
the chemical theory of physic, till about
the latter end of Elizabeth's time.

Pharmacy about the latter end of
last century was carried to an exorbitant

x This is now published

degree Schroder, D: Ludovicus & Bates are examples of it, and persons were appointed by public authority to make up their compositions, hence the office of Apothecaries. There being a necessity likewise for some known & certain manner of compounding medicines, public dispensatories were com=:piled for that purpose. The best Dispensatory now in print is the London of 1746 & we hear the college of Edinburgh is now compiling a Dispensatory if poss=:sible to surpass that of London.ˣ The Sweeden dispensatory is reckoned to exceed that of Paris in simplicity.

The improvements in chemical pharmacy since the time of Paracelsus are many: instead of compounds we have now simples: instead of many few distilled waters as being of but little efficacy in medicine: instead of extracts we have

infusions; instead of many distill'd oils but few; as all distill'd oils are nearly alike in virtue; instead of the many vegetable essential salts few or none, as salt of Tartar or Potash are as good as any: Copper & Silver as too corrosive, & Lead & Tin as too astringent, except for external applications are exploded

Philosophic chemistry

Having finished our account of ~~philosoph~~ pharmaceutic chemistry we proceed to the last division. Though we have proved that the Arabians introduced chemical pharmacy yet we dont find they ever apply'd chemistry to philosophy. Paracelsus being the first who introduced chemistry into the Theory of Physic, he held that a tartar obstructs the vessels in diseases.

Another chemical theory was afterwards introduced by Van Helmont who was born

in the year 1577 of a noble family and was educated in the Galenic system of physic but afterwards leaving that he embraced the Paracelsian, or rather he introduced one of his own for he asserted that an archeus or universal spirit was the principle of all bodies, he was in some measure followed by Wepfer & Stahl, the latter calling the archeus by the name of anima medica. From these instances we see how some of the most learned & judicious men have been mislead by these false chemical theories.

Descartes also founded a theory of physic & philosophy w.ch being entirely theoretical was soon after exploded & is now never mentioned but with ridicule; he ascribed the causes of diseases to effer=:vescence, fermentation &c: reckoning acids and alkalies as their origin But the time is now at hand when the true philosophy

is to appear; Bacon & Galileo, the former by applying himself to natural philoso:phy the latter to the mathematics, first began the same.

Borelli Bellini, but particu:larly the great Pitcairn introduced a mechanical Theory of physic in wc. they attempt to explain the causes of all diseases on mechanic principles, which, tho' seemingly nice & true, is nevertheless often erroneous, as were all the preceeding theories, there never having appeared a compleat system of physic, founded on the true structure of the human body and supported by observations and experiments, 'till Boerhaave favored us with one.

The Greeks being but little versed in natural philosophy, the Lattins and

Arabians little exceeded them, contenting themselves with the peripatetic and Epicurean philosophies w.ch prevailed till the restoration of learning about the 15.th century when it began to be a little improved tho' sparingly till the 16.th century when Bacon and Gallileo, as before observed, greatly improved the same. After them appeared the great M.r Boyle who history informs us was born the same day that Bacon died, and is the first to whom we are indebted for true philosophical chemistry. He declared he rec.d more instruction in the shops of mechanics than from the voluminous writings of all his predecessors. He kept up a regular

correspondence with all the chemists in Europe & with <u>Sir Isaac Newton</u> which made his works more famous, nor is there any authors worth reading before him except Agricola & Lazerus Erchens.

Since his time chemists by pur:suing his method have greatly im:proved & enriched this art. <u>Glauber</u> greatly enriched chemistry by his discoveries as did <u>Kunckel</u>. After these chemistry was improved by means of societies, the first of w.^c^ was the royal society at London. the French however have exceeded the English in chemistry. <u>Homberg</u> was a good chemist, he said acids were sharp pointed kneedles & that alkalies were spongy which by

sheathing the acids in their pores
blunted their acrimony & rendered
them mild. After him appeared
the two Lemery's, then the
Geoffroy's with several others who
applyed themselves to particular
parts of chemistry, as Raumeur on
Iron — Duhamel on vegetation —
Hellot on mettallurgy. In Germany
were Stahl, Junkeh, Hoffman &
Cramer, & Potts, but Marggraaff
is accounted the best; next to him
are the Suceds. Lewis is the best
chemical writer in England, but
Macquer in France is the best of
them all. The chemical works of Casper
Neumann translated by Lewis with notes
is an excellent book, but Lewis's Commercium
philosophico-technicum is still better.

Dr. Stahl was the author of a chemical theory which has been generally adopted by all Chemists since his time until very lately. According to him an inflammable principle or what he calls Phlogiston is the cause of most of the phaenomena produced by Chemistry. The Stahlians suppose Sulphur to be a compound formed of phlogiston & the vitriolic Acid which may be decomposed by separating these component parts; that Metals are composed of a particular Earth & phlogiston which are reduced to a calx by separating the phlogiston from the Earth & again restored to their metallic state by combining the phlogiston with the Calx.

Since the discovery of the different kinds of Air which exist naturally in the atmosphere & the distinct properties of pure Air a new theory has been adopted by some Chemists directly the reverse of Stahl's. These Chemists deny the existence of phlogiston altogether. They assert that pure Air is the principle which produces the chemical changes in bodies & that all the phenomena which the Stahlians suppose are owing to the

x vid Fourcroy's Chimistry vol 1 p. 102, 334, 357

separation & combination of phlogiston arise from the separation or combination of pure Air inversely of ~~Stahl's~~ Stahl's theory, for they attribute the change which the Stahlians suppose arises from the separation of phlogiston to the combination of Air, & vice versa; thus
1 The Stahlians suppose phlogiston constitutes combustibility in bodies, according to the new or pneumatic Chemistry a very great tendency in bodies to unite with pure Air constitutes combustibility.
2 In all cases where the Stahlians think the phlogiston disengaged, these Chemists suppose combinations of pure Air take place, as in combustion & calcination
3 In all instances, on the contrary, in which the doctrine of Stahl supposes the phlogiston to form a combination, the pneumatic theory supposes this Air to be disengaged. as the reduction of metals &c:
4 All the bodies which Stahl supposes to be compound containing phlogiston, accord: to the new doctrine are simple substances which have a great affinity with pure Air, as Sulphur, Metals &c: x

A course
of
Chemistry

5

Introduction.

As all the arts by which matter is diversly modified & accommodated to human uses, have a necessary dependence upon the properties or qualities of the bodies on which they are exercised; enquiries into the properties of different bodies, & the effects resulting from various applications of them to one another, become apparently of primary importance.*

The properties of bodies make the object of natural philosophy which may be defined "a science that treats of the properties of all created bodies," and is divided into two parts, mechanics, & chemistry, or the mechanical & chemical branches of philosophy, which tho' in many cases so closely interwoven, & so nearly allied, that perhaps no boundaries can be established between them, appear in others to have essential & important differences.

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* Lewis's Commercium &c. in Introduction

Chemistry therefore is properly a branch of natural philosophy, or, according to logicians philosophy is the genus of which this is a species. It may be defined to be "that part of natural philosophy which treats of the particular properties of bodies, in contradistinction to mechanics, which is that branch of natural philosophy which treats of the general properties of bodies."

In order then to ascertain the proper limits of these two branches of science, it's necessary to distinguish between the general & particular properties of bodies

Bulk, size, figure, form, gravity, motion &c: belong to every kind of matter and are therefore general properties

The particular properties are those w.^ch^ belong to certain bodies only, as the ductility of gold, hardness & frangibility of a diamond, the elasticity of Iron &c:

From hence we see the difference between these two distinct branches of natural philosophy.

the former or mechanical part sometimes called mathematical philosophy being only conver:
:vant in the general properties of matter or bodies, whilst the latter or chemical philo:
:sophy is occupy'd in treating of their particular properties; & hence it is that the general properties of bodies is always synonimous to their mechanical properties, but when we use the term particular properties we always mean the same as chemical proper:
:ties, which is necessary to be attended to. — Thus, for example a knife or a wedge, if we neglect the consideration of the matter of which they are made, & only take notice of their size, shape, figure &c: this is a mechanical consideration as it may be apply'd to all knives & wedges of whatever matter they are made; but if we want a knife or a wedge of a particular kind as very sharp & hard all matter will not answer this end, therefore ~~we~~ must take into consideration the particular properties of matter in order to

find out some body endowed with this necess:
:sary property, as we find iron or steel is;
this is an object of chemical philosophy.

But notwithstanding this obvious distinction we ought to be very attentive in order to avoid mistaking properties, it being many times very difficult to distinguish between the chemical & mechanical properties of bodies

Some alledge if we had a sufficient degree of heat all bodies would become fluid as we know diamond may; others assert that all fluid bodies may become solid if we had a sufficient degree of cold, as some late experiments evince that mercury may be reduced to a solid state by a certain degree of cold: but neither of these opinions are sufficiently ascertained by a full induction: if they were we should consider fluidity & solidity not as particular but general properties of bodies. But whilst this induction is not fully proved

& some bodies always continued solid & others perhaps fluid it is sufficient for us to consider them as chemical or particular properties

Perhaps it may be further objected that the particular properties of bodies is only owing to general properties variously modified which produce the particular properties, if so then our definition of chemistry is false? To remove this objection of the corpuscular doctrine, though I allow that particular properties may depend on some general properties, yet since they have not yet made it plain that they can be referred to any general properties of bodies we may continue our definition, & especially as the particular properties which we are to treat of are widely different from any thing we can see in universal or general properties, so that our distinction & definition of the proper subjects of chemistry is very proper & seems to have a good foundation in nature

According to Lord Bacon the end of natural philosophy is to know the causes of effects so as to be able to induce or destroy properties as the necessity of life may require. Chemistry therefore as a branch of philosophy is the investigation of causes of effects & tis now well known this can only be done by an induction of particulars; hence all science may be reduced to two heads 1.st The History of facts, and 2.d philosophical knowledge of causes. And in this manner ought we to proceed in our chemical enquiries.

In order to proceed methodically in our present undertaking it will be necessary 1.st To premise a general account of the objects of chemistry, & to explain the terms that are made use of in this science or as it were to make you acquainted with the language of chemistry w.ch is often remote from the language of common

else or of any other science. Then 2^dly give a general account of the operations and Instruments of Chemistry. And 3^d & lastly the chemical history of Bodies. To render the course compleat a fourth ought to be added viz. the doctrine of the qualities of bodies but from the present imperfect state of this science it is impossible

As to the first the objects of chemis=:try. Here we ought to be conversant in the distribution of natural history. Accuracy of division & proper distribution under genera & species runs through more parts of science than any thing else; nothing should be wanting to understand this, as on it depends the knowlege of what is to follow which would otherwise be unintelligible. This part of our work cannot be compleat but by an

Induction of all the properties which is the buisneſs of the third part. Here only we mean a general Idea to be rendered more compleat afterwards.

With regard to the second part, one use of it is that it will serve as a neceſsary preliminary for understanding the third or the chemical properties of bodies; it may further serve as an introduction to the practice of chemistry, and since a knowlege of the means by which the qualities of bodies are changed is a neceſsary step towards understanding the causes, we may hence see of what advantage it is to the theory of chemistry.

These two parts tho' only introductory to the third or principal part are never=thelesſ to be considered as fundamental

Having said thus much of chemistry in general we come to treat particularly of 1.st part

Part 1st

Of the objects of chemistry

Some have thought that they might be called the subjects of chemistry, but we choose to make use of this term as more comprehensive taking in the substances of meditation as well as operation.

Dr. Boerhaave's definition of chemistry in his system of chemistry is faulty, he has given us a better one in his methodus studii medici as published by Haller.

Dr. Shaw defines it thus "The whole art of chemistry may be comprehended under the skill of resolving bodies into their principles & of constituting new compounds from those principles by means of proper agents; so that the one may properly enough be distinguished by analytical the other synthetical chemistry, the former reduces bodies to their component

matters, the latter puts these component matters together in various manners & thereby forms a large set of new productions that would be absolutely indiscoverable in nature without the interposition of this art, as for instance, brandy, soap, glass, vitriol &c:"

This diffinition also faulty in making all bodies in all circumstances the objects of chemistry, whereas they are not, only so far as they are possess'd of particular properties.

Dr. Cullen defines chemistry to be "that part of natural philosophy which treats of the particular properties of bodies." This the most concise & truest definition of chemistry that can be given. We say therefore the objects of chemistry are every corporeal substance that seems possessed of

particular qualities; and that every operation that produces a change in the particular properties of bodies is chemical.

The objects of chemistry considered in general are Elements or mixts

Elements are physical otherwise named atoms, or chemical called chemical principles

Such particles of matter as are not changeable by any powers in the system of of nature are called Physical Elements or Atoms, which term denotes their unalterable nature

The simplest parts into which the ultimate efforts of chemistry can divide bodies or separate them from one another are called chemical principles.

The first are established by nature, the second by Art.

Table I.

Bodies in general are Elements & Mixts.

Elements are

Physical or Chemical	Atoms Principles

Mixts are

Mixts strictly so called
Compounds
Decompounds
Superdecompounds

Sensible bodies are

Mixts that may be resolved into Constituent parts
or Aggregates that may be divided into Integrant parts

Table II

Particular bodies are

Saline
Inflammable
Metallic
Earthy
Watery

Table III

Saline bodies are

Simple or Compound.

Simple Salts are

Acids & Alkaline.

Compound Salts are

Neutral
Metallic
Earthy

Acids are

vitriolic, Nitrous, Muriatic, Vegetable.

Alkalines are

Fixed and Volatile

Table IV.

Inflammable bodies are

Oil
Sulphur } Phlogiston.
Ardent Spirit

Oils are

Animal Vegetable or Fossil.

Animal & Vegetable Oils are

Expressed	Fats, Wax, Gums.
Essential	Balsams, Resins
Empyreumatic	

Fossil Oil	Bitumen
Sulphur mineral	Brimstone
Ardent Spirit	Ether

Table V

Metallic Substances are

Metals or Semimetals

Metals are

Noble & perfect as Gold & Silver, or

Base & imperfect as Lead, Tin, Copper, Iron.

Semimetals are

Quicksilver, Antimony, Zinc, Bismuth,

Arsenic, Platina, Cobalt, Nihil.

Ore Matrix

Table VI

Earthy Bodies are

Absorbent Alkaline, Calcarious

Crystalline vitrescent

Argillaceous

Gypseous Selenites

Talky

Water is

Common or

Mineral

Table VII

The Changes of the qualities of bodies effected by Chemistry are all of them produced by Combination or Separation

Combination depends upon Attraction & this upon Fluidity which is employed in Solution or Fusion.

Separation depends upon Elective Attraction or the Action of the Fire.

Elective Attraction, as attraction in general, depends upon Fluidity and therefore also upon

Solution or Fusion

The Fire separates bodies in consequence of their different degrees of Fusibility & acts by Fusion; or their Volatility & then acts by Exhalation.

Hence all the several operations of Chemistry may be referred to

Solution Fusion or Exhalation.

Instanced in the effluvia of Assafoetida & the solution of Copper Hum vol: 1. p 91.

Of physical Atoms.

Whatever mathematicians may assert of matter's being divisible ad infinitum, we have the highest reason to believe such a divisibility is only imaginary or as we may so say it is indefinite & the ultimate particles or Atoms of which a body is com:posed may elude all human ingenuity to arrive at.

It is true there are many surprising instances to be met with in Authors of the exceeding minuteness into w.ch the particles composing a body may be divided as appears in the effluvia of odorous bodies & the solution of solid in fluid bodies.

The analysis or decomposition of bodies is finite & we are unable to carry it beyond a certain limit. In whatever way we attempt to go farther we are always stop'd by substances in which we can produce no change; ~~& which are incapable~~ & w.ch are incapable of being resolv'd into others ×. These substances which cannot be further resolved into others, may and are by the chemists likewise termed primary parts; and the Substances com:pos'd

× Macquer vol: 1 p 2

-posed immediately of these first Elements are called secondary principles. ×

The different natures of bodies arise from the different combinations of the primary parts with each other, & the interchangeable coalitions that take place between them & which may be called the mode of aggregation in bodies, from the difference of which result the different qualities of bodies

Atoms are not of one sort only. The union of many Atoms of one kind produce simple bodies, whereas the union of both primary & secondary principles gives the name of compound or mixt to any body

Supposing a body to be simple, I confess for my own part all that I can conceive how is, that any such single body is composed of lesser bodies perfectly like the greater, & these again in the same manner of smaller & so on beyond any limits that the mind is capable of fixing: that there is a certain principle implanted in some corpuscles by the great Creator, by which they are united & formed into little masses, which it is not possible for any

× Macquer vol 1: p 2, 3.

any natural or artificial power to separate asunder, & which of consequence remain always the same, not=
:withstanding all the violence that can be exerted upon them: And lastly, that these may be concreted with one another, and by their reciprocal attraction, produce so firm an union as will be very seldom destroyed & then only by some few particular causes, which will be able to effect nothing more upon them than barely dividing them asunder & reduing them again to their original state; for then they will be perfectly immut=
:able as they were before. Hence we understand what were the Atoms of Democrates, the <u>monads</u> of some philosophers, the <u>hylarchic</u> principles of others, & the last principles of almost all philosophers in general.*

These particles are quite solid having no vacuity or pores within them, not even to admit the element of fire itself within them: and hence they are neither dilatable by any natural power or reducible into a less space, or capable of changeing their form. If any body now is composed of particles thus perfectly Solid: (by) absolutely Solid

* Boerh: Elem: chem: vol: 1 p 92.

Solid is meant, such an extended being where there is not the least penetrable space) & if these solid particles are so united together, that there are little spaces left between them that contain nothing solid: then it appears evidently that such an extended bulk is partly body and partly Space, and it is hence evident likewise that the smallest Elements of bodies will be most solid; & that when these are afterwards compounded into one mass, then betwixt these elements thus united together but not touching one another in every point, there will be formed such spaces within that body. The compound mass will therefore be always full of pores, & consequently less solid than the ultimate elements of which it consists; & hence in this respect the parts may be more easily separated from one another, or are capable of a more easy division.* The masses then which are made up of Substance with intercepted pores or vacuities, may be so far divisible as they contain these pores within them. Thus a dissolving body endued with

* Boerhaave's El: Chemistry vol: 1 p 230 —

with great subtilty may penetrate into the pores of the body to be divided, exert its force there, sepdrate the connected filaments & particles & thus resolve the compounds into their simple elements.

Mixts, are

Mixts, strictly so called

Compounds

Decompounds

Superdecompounds

The term *Mixt* implies a various modification of matter, that the primary parts or physical Atoms of which a body consists are not alike & the same, but somehow different in size or figure.

As a simple body supposes an aggregation or union of similar elements join'd together, as in Water in which every drop is alike, so the chymists apprehend a mixt body to be made up of dissimilar or unlike Elements.

By a *Compound* they understand a union of different

different mixts combined together into one body, and a variety of compounds collected together according to them make a decompound, & two or more decompounds form what they call a Superdecompound. Thus for Example Salt & Water form a mixt body, Earth & Oil form likewise a mixt body each mixt being made up of dissimilar principles; all these being united together form a Compound.

In like manner Cinnabar whether native or factitious is a compound body, being made up of two different mixt bodies viz: Sulphur & Mercury, for Sulphur is capable of being resolved by chymistry into an Acid of a peculiar kind & an inflamable principle term'd phlogiston of whose nature we shall speak more fully hereafter; And Mercury or Quicksilver consists of Earth and another principle or element which is called the mercurial principle. Soap is also a compound body being made up of an alkaline Salt & an Oil each of which separately considered are

are a mixt body made up of different Elements. the union of Soap & Cinnabar which are two compound bodies form a Decompound, and these being united with another or more decompound bodies as with the Metal of Iron & any Syrup or Mucilage may form an Electuary which in the language of Chymistry is a superdecompound body.

As the breaking down of mixt bodies into their constituent parts is called the resolving of bodies into their principles; so the term of decomposition is made use of by Lord Bacon, Mr Boyle & other accurate philosophers & chymists to signify a higher kind of resolution or the breaking down of the higher orders of composition into their component parts.

The use of these distinctions will appear from hence, viz.t that from compound bodies, decompounds or superdecompounds, we cannot always easily & at once by a single operation separate the first principles

principles of bodies from each other. we frequently obtain by a chymical Analysis of the higher or more compound order of bodies a separation of the parts which make a compound by one operation & by a second & third operation &c: on each of these apart or united with other bodies we gradually arrive at their chymical principles i.e. as we said before to those parts which cannot be further resolved into others by any human contrivance.

Another division of bodies is into Single and collective.

Single bodies are those which being join'd make up an Aggregate.

Collective bodies or Aggregates are a collection of many similar bodies into one. All the natural bodies which fall under the notice of our Senses are aggregates according to the common mode of Expression.

The parts of an agregate are generally esteem'd some

homogeneous as the most simple water we can any how procure by Art. The parts of a mixt are commonly reckond heterogeneous as of brandy which may be easily seperated into water & Alkohol.) Thus a foundation is laid for distinguishing Aggregates into homogeneous aggregates when the integrant parts are a simple body & into an heterogeneous aggregate the integrant parts of which are not a simple body or principle not further resolvable into others —

But we must in our reasonings on this subject endeavour carefully to distinguish between the Ideas of a mixt & an Aggregate, e.g. Integrant parts compose an aggregate, dissimilar parts compose a mixt; If we reduce Nitre to a fine powder & divide it into grains every grain may be called an integrant part because each grain has the same chymical property. Again the same Nitre may by an easy operation be resolved into two different parts viz.^t an Acid & an Alkali, these are called constituent parts & when united make up the Mixt, as integrant parts make up the Aggregate.

When we speak of breaking down a body into its integrant parts we call that operation Division, but when a body is broke down into its constituent parts we call it Resolution; this distinction of Terms ought to be well attended to in order to understand what is delivered with the greater accuracy and precision.

We may further illustrate this distinction by an example taken from mixt metal. If one ounce of Silver thoroughly incorporated with twelve ounces of Lead be broke down into ounces pennyweights & grains, each of these parcels are called integrant parts every one of them contain twelve parts of lead to one part of Silver; but if by any chymical operation we procure an entire separation of the Silver from the Lead we call this a resolution of the body into constituent parts.

The properties of bodies are by some suppos'd to be always the same provided there be no addition made to, or any subtraction from, those bodies; such philosophers assert that the change of fluid water into Ice or of Ice into fluid water is effected in the first

case

case by the introduction of certain frigoriferous particles from the cold air which they had not before, & in the latter case by the expulsion of said particles on the encrease of heat to a certain degree.

Other great philosophers contend that the changes in the properties of bodies result chiefly from the differences which take place in what they call the mode of aggregation in the elements or principles of bodies which may be varied by the action of external agents or the presence or absence of those agents, & the different circumstances in which bodies are united together. Thus they say water is a body that alone & in a separate state is always fluid in the common temperature of our Atmosphere, or when the heat does exceed 32 degrees above 0 in Fahrenheit's Thermometer, & in that State the parts easily move upon or recede from each other upon the least force impressed upon them: a greater degree of cold they say or the absence of heat occasions a difference in their mode of aggregation from whence the particles attract each other with such force as no longer to recede from each

each other whilst that mode of Aggregation continues but is broke into irregular fragments as any other solid body according to the force made use of for that purpose

Besides applied to one another they observe will show different effects according to the mode of aggregation in which they were applyed to one another. It is a curious phenomenon in chymistry that water in its fluid state being added to Aqua fortis will generate a greater degree of heat than subsisted in either of those bodies previous to such union, or in other words they collect & accumulate a greater quantity of fire; But if the same water be frozen into solid Ice & applyed in that state to Aqua fortis it generates or produces a greater degree of cold. By these instances we may understand what is meant by a difference in the arangement of the particles in a body or the mode of their aggregation, & on what foundation they assert that a different mode of aggregation will always produce a consequent change in the sensible qualities of bodies.

Many persons have fondly indulged a hope that if they

they could but tell what ingredients or principles entered into the composition of any body they should be able to know à priori what would be the effect or what would be the qualities arising in the mixt or compound, supposing there would be no other than a blending of qualities which pre-existed in the principles separately. But it is the nature of a true mixt to alter the mode of aggregation, to produce new arrangements in the parts of the body, & new qualities which the most prying & wise of philosophers could never have imagined or known but from Experience and observation —

This may serve as a lesson to the students & practicioners of physic not to be careless in the composition of medicines, or inattentive to their effects. Every new composition in which a true mixture takes place between the parts of any two ingredients will occasion a set of different proper=ties from what pre-existed in the Ingredients, & may prove either salutary or unexpectedly noxious to the patient when the prescriber is ignorant of the

the chymical changes brought on from such an union. Yet every composition is not of that nature, for a great number of Ingredients may be injudiciously jumbled together in such a manner that each acts according to its nature in a separate state, & all excite a variety of confused & different effects on the System, which answer no valuable purpose & which cannot be ranged in any order or answer any particular Indication in the cure of diseases.

A judicious composition or mixture of bodies whose effects we know both in a separate state & in a state of mixture will ever distinguish the skilful physician & learned chymist from the illiterate and ignorant pretenders in the health giving Art of physic & shews of what consequence a proper knowledge of chymistry is to a well bred & regular physician.

Unless it had been first evinced by experiment what mortal would ever have been able to tell, that essential oils as that of Turpentine might be set on fire by the sole mixture of concentrated acids. but the fact is ascertain'd by Experiment.

"Mix together in a vial equal parts of concentrated oil of Vitriol & highly smoking fresh drawn Spirit of Nitre; pour this mixture at several times but suddenly on three parts of oil of Turpentine set for that purpose in a glass vessel (by a part here must be understood a drachm at least) a most violent commotion accompanied with Smoke will be immediately raised in the liquors, & the whole will take fire in an instant flame and be consumed." v: Macquer vol 2 p 149.

There is not in chymistry a phenomenon more extraordinary and surprizing than the firing of oils by mixing them with Acids. It never could have been suspected from any notion we have of the principles of these bodies, that a mixture of two cold liquors would produce a sudden, violent, bright, and lasting flame. (Macq: vol 2 p 149. 150.)

see also Neumann vol 1. p 303 in nota.

Division of chemistry } –

M: Fourcroy in his Lectures on Chemistry divides his subject into the 3 Kingdoms of Minerals Vegetables & Animals.

He divides the Mineral Kingdom into 3 Classes. The first comprehends Earths & Stones the second Saline Substances, & the third Combustible Substances.

Definitions –

It has been usual for chymists to follow the order generally observed by the writers of natural History & to distribute the subjects of which they treat as they are found in one or other of the three kingdoms of nature viz. the animal the vegetable & the fossil. However well this order may suit the former, it is a less convenient method for the latter as will be shewn when we come to deliver the chymical History of Salts: A much better method is that first proposed by the ingenuous Dr. Cullen of Edinburgh in which all the objects of chymistry are referred to one or other of the following Classes viz.t Saline - Inflammable - metallic - Earthy - & watery, which I am now to distinguish from one another by proper characteristics.

1.st A saline body is sapid to the taste, is soluble in water & not inflammable.

2.dly Inflammable bodies are such as being once set on fire continue burning till the whole or the greatest part of the substance is destroyed though they remain not in contact with any other heated body. They propagate the burning quality from one part of the mass to all the rest

rest, & have their surface covered with a luminous appearance, to which add that they generally emit a flame whilst they are burning as Wax, Oil, &c:

The term inflammation is to be accurately distinguished from ignition which implies a body's being red hot, & which may set other bodies on fire which are inflammable; but such ignited bodies themselves upon being withdrawn from the fire immediately begin to cool, whereas an inflammable body as we have observed already, continues to propagate its burning quality when set on fire thro' the whole mass, till all the inflammable matter is consumed.

Several of the chymists in their definition of inflammable Substances have said they are not mixable with water, but improperly for Alcohol mixes very readily with water & is one of the most inflammable substances of the whole class.

3:ly Metallic Substances are not soluble in water, they are not inflammable, but are fusible in the fire, & being withdrawn from thence they concrete into

into the same precise solid form which they had before they were fused — they are also opaque & possessed of a very great specific gravity

4.ly Earthy Substances are solid bodies commonly found in a dry form; they are not soluble in water nor inflammable: they are either not fusible in the fire, or if so, do not upon being withdrawn from thence concrete into a similar form with that they had before but into that of Glass.

5.ly Water is an insipid uninflammable body, is commonly met with in a fluid form, & whenever it takes a solid form as that of Ice it melts again into a fluid state in a certain degree of heat as 33 deg.s above 0 in Fahrenheit's thermometer, & in a less degree of heat as 30° again assumes the same solid form of Ice which it had before.

By the above marks it is distinguished from every other body — In most of them it agrees with mercury but is distinguished from that body in being transparent when pure whereas mercury is opake & also requires a very great degree of cold to render it a solid concrete.

Subdivisions -

× There are 2 general classes of simple salts acids & Alkalies.

There are 4 kinds of acids vitriolic nitrous muriatic & vegetable.

There are 3 kinds of alkalies viz. two fixt a fossil & vegetable & one volatile.

Neumann

Fourcroy makes 2 orders of saline substances

1 Simple or primitive saline substances.
2 Secondary, compound or Neutral salts.

Of the first order he makes 3 Genera

1 Saline Earthy substances of w.c he makes 3 species
2 Alkaline Salts of w.c he makes 3 species
3 Acids (mineral) of w.c he makes 7 species

Of the second order he makes 6 Genera

1 Neutral Salts with Base of fixed Alkalies — 12 species
2 neutral salts with base of vol: alkali — 6 sp:
3 — — — with Base of Quicklime — 6 sp:
4 - - - - with Base of Magnesia — 6 sp:
5 - - - - with Base of Clay — 6 sp:
6 — — — with Base of Terra ponderosa 6 sp:

Having defined the terms made use of as they are applyd to the particular objects of chymistry in their most extensive acceptation. We now proceed to the subdivision of these bodies.

1.st Saline Substances

Salts are either simple or compound. *

We call those Salts simple which enter the compos.n of other saline bodies & that are the most simple of that order or class of bodies which we call saline — these are acid or alkaline, which are the only simple Salts we know of

Acids are saline bodies which have a sower taste (what that is can only be learnt from experience, to which we refer you, as it is a simple Idea that does not admit of a logical definition) applyed to the Syrup of violets they change its color to that of red. *

Alkali is a saline body having a peculiar taste sui generis; it generally produces an effervescence on being applyed to an acid unless it be in a caustic state, but being applyed to the Syrup of violets it changes the colour of the same to that of green. *

* Neumann vol 1 p 244 —

N3. The Syrup should be somewhat diluted w.th water to make those colors appear more conspicuous on the application of these simple salts.

Compound Salts are such compound substances as have the distinguishing marks of salt. They have always one of the simple salts at least, that is an acid entering into their composition. — There are but three substances that can form a compound Salt by uniting with an acid viz.t alkalis, metals & earths,

✱ The union of an acid with the first viz.t an alkali forms what is called a neutral Salt; because from these two simple Salts seemingly of so opposite a nature to each other combined together in such a certain proportion, in which alone a perfect union can take place the particular qualities of each of these bodies are so entirely altered, that the qualities of neither of them are any longer perceived or prevail over the qualities of the other, but are blended & lost; so as to produce a tertium quid or body possess'd of qualities which neither had in a separate state; nor does it in the least change the color of the Syrup of violets or other vegetable blues to that of green or red

There are 4 principal genera of Acids viz. The vitriolic, the nitrous, the muriatic & the vegetable Acids.

These characteristic names are borrowed from the substances from which they are procured.

The vitriolic Acid is so called from its being most generally obtained from ~~vegetables~~ vitriols. When concentrated to the utmost of which it is capable, it is of greater specific gravity than the other acids being to water as 18.778 to 10,000 see Neum: vol i p. 246.

The nitrous Acid is extracted from nitre or Salt petre as it is called: it is known by its suffocating fumes & by its great specific gravity when most concentrated, being then next in order to the vitriolic acid, & to water as 15 to 10 or nearly.

Muriatic acid is a name given from the term muria which signifies brine, to the acid obtained from sea salt – it is often called the marine acid – when concentrated it is next in order to the nitrous acid for specific gravity being to water as 12 to 10.

The vegetable acid is so called on account of its being obtain'd from vegetable substances – It is the weakest of all the acids & of the least specific gravity being only when concentrated to water as

at that time as well as in propagating the inflammation in all

Alkalis are either fixed or volatile.

Fixed Alkalies are inodorous, that is they do not emit any smell or exhale an odor in the open Air.

Volatile Alkali exhales an odor in the common temperature of the Air & is endowed with a pungent Smell.

Both the fixed & volatile alkali shew the same effect when applyed to the Syrup of violets

The compound Salts are neutral, metallic or earthy.

* The term of neutral is confined to those Salts which are composed of an acid & an alkali.

The term of metallic Salt is derived from an acid being combined with a metal so as to produce a compound salt.

The term of earthy salt is given to that comp: salt which is made up by the union of an acid with an earth.

2.d Inflammable Substances

All matter that we know of is capable of recieving heat whilst in contact with burning fuel & it retains adequ of heat for sometime, but gradually parts w.th that heat when withdrawn from the fire or burning fewel, but inflammable bodies differ however from bodies not inflammable in the flame w.ch is kindled about them & the luminous app.ce they have at that time as well as in propagating the inflammation thro' all

* Fourcroy makes 5 Genera of Combustible Substances
1 Diamond
2 Inflammable Gas. Inflam:ble Air of Dr Priestley
3 Sulphur
4 Metallic Substances
5 Bitumens

* See Macquer vol 1: p 9 Neum:n vol 1 p 79
This doctrine of a phlogiston is now denied by some Chemists who substitute pure Air in its place - see Fourcroy. Combustion is nothing but the Act of the combination of pure Air with the combustible body - this is evident.
1 a body cannot burn without Air. 2 The purer the Air is the more rapid the combustion 3 In Combustion there is an absorption of Air & increase of weight in the body burnt

all the substance of the inflam^ble body when left in the open Air, till the whole of the combustible substance it cont.^d is quite consumed.

The great number of bodies that are endowed with this property exceed my power of calculat.^g, nor is it necessary for us to enumerate each particular

From the great diversity of forms we may nevertheless select 3 classes of inflammable bodies to one or other of w.^ch the inflam.^b of all bodies is suppos'd to be owing viz.^t Oil, Sulphur, & Ardent Spirit.* All other bodies capable of burning are supp.^d to be more heterogeneous than these & one or other of these inflam.^ble principles is supp.^d to give those bodies their combust.^ty property — But chymists pursue this speculation much further. They imagine that there is some one principle or elementary substance the same in all these three diff.^t form of bodies to w.^ch the inflammab.^ty of them all is owing & that it is united with somewhat in each that is not inflammable of itself, but w.^ch being differently comb.^d with ~~othe inflam~~ ~~principles~~ ~~of each of these~~ all their respective forms.

To this supp.^d inflammable principle they have affix.^d the term of phlogiston^x & believe that if Oil Sulphur & ardent Spirits were deprived of this phlogiston they would be no longer capable of burning, nor any longer merit the name of inflammable.

Oils are animal, vegetable or fossil & are so called after ~~from~~ the names of the subject matter from whence they are obtain'd

Animal & vegetable oils are divided into expressed, essential and empyreumatic.

7.

Expressed Oils are so called because they are got from certain animal & vegetable substances, particularly certain fruit & seeds by bruising & squeezing them in a press between iron plates. These oils have scarcely any smell or taste. Oils of this sort are very mild & unctuous; & because in this respect they generally resemble animal fat more than the rest do, they are also call'd fat & unctuous oils. Besides, these oils having little or no peculiar smell, they are mild to the taste & are not soluble in Spirit of wine

Essential Oils are so nam'd from a supposition of their being the essence of the Substance on acct: of their odor wch is so exactly like that of the substance from wch they are procured; their acid taste & solubility in Spirit of Wine.

These are often obtain'd from certain vegetables by mere expression, nor are they confin'd to vegetables alone as some have mistakenly imagined, but are also to be found in animal bodies. The effluvia arising from a living animal body is of the same nature wth this essential oil & is what enables the sagacious dog to distinguish & know his own master amongst a thousand other ones & by which the keenly scenting hound is able to scent & pursue his game though out of sight & to continue the same track through all the turnings & windings of the hunted prey in vain attempting to escape

Empyreumatic Oils obtain that name from an empyreuma or particular burnt smell & taste which they get from the fire. They are distinguishable further from expressed oils by their being acrid to the taste soluble in spirit of wine; & from essential oils by their not having the peculiar smell of the substance from whence they are got

Animal fats come under the head of expressed oils.

Wax is an extract from vegetable substances made by the laborious bees. It differs from expressed vegetable oils in its consistence. It may be considered as a particular prodn of nature or art, but from its near relation therewith is included under the head of oils, & may be looked upon as a kind of solid oil

Gums are exudations from vegetable substances; they are bland, insipid & without odor, they are of a thick consistence, are soluble in water but not in Spirit of Wine

Balsams & Resins are also spontaneous exudations from vegetables, that are soluble in Spirit of Wine & not in water; & they differ chiefly or wholly in their degree of consistence, the resins being dry friable or thickned balsams.

Essential Oils by long keeping take the appearance of Resins or Balsams & by a ~~particular~~ operation Balsams & Resins may be converted into essential oils—

Fossil Oils are those which are procured out of the bowells of the earth. The petroleum or what is called

barbados Tar from the quantities imported from thence has a strong smell wch is not disagreeable. It's color is sometimes more sometimes less yellow. There are certain mineral substances wch yield by distillation a great deal of oil very like petroleum this sort of substance is call'd, Bitumen & is indeed nothing but an oil rendered consistent & solid by being combin'd with an acid as appears from hence that by uniting Petroleum with the vitriolic Acid we can produce an artificial bitumen much like the native *

Petroleum, Oleum Terrae, Piceleum, Asphaltum, asphaltum or bitumn judaicum & perhaps pitcoal are all the same kind of productions & have a naptha for their basis & differ principally according to the different circumstances quantity & appearance of heterogeneous matter mixt wth it.

To the head of Oil belongs Æther which is a comp inflammable body obtain'd by Art from the union of ~~the~~ Acid & Alcohol by a particular encheiresis *

Æther is an odorous fluid inflammable & not miscible with water, so far it agrees with essential oils, but differs from them in regard to ~~its solubility~~ of its not being soluble in rectified Spirit of wine

Sulphur or Brimstone is a solid brittle concrete of a yellow color inclining a little to greenish in some degree

* mac: vol: 1 p: 105 * d: vol 2 p 239

glossy. Held in the warm hand it crackles or bursts & leaves on the hand a peculiar kind of smell. It is nearly 2 as heavy as an equal bulk of water" & is an highly inflammable substance obtain'd from the fossil kingdom.*

*1 Newman 254

Ardent Spirit is an inflammable fluid mixable with water; when we call it spirit of wine we consider it as not entirely pure, but rectified to a certain degree; when it is mixed with equal parts of water it is called proof Spirit; when it is freed from water as perfectly as we can procure it by any means it then has the name of Alcohol.

3.d Metallic Substances

"Metallic Substances are divided into metals, or those which are capable of being worked & considerably extended under the hammer; and Semimetals, or those which want that valuable quality. There are other characters also no less discriminative of the two classes. metals appear when broken of an uniform, a fibrous or a granulated texture; whilst the broken surfaces of Semimetals (the fluid one Quicksilver excepted) are composed of large angular plates or flakes". vide Newman vol 1 p. 48.

Metals exposed to the most intense degree of ordinary fire, if the air is perfectly shut out, remain fixed and unaltered at the bottom of the vessel whilst Semimetals

impatient of vehement heat arise in fumes into that part of the vessel w.ch is furthest removed from the fire & then condense again into their original form. Neum.n

Though neither metals or Semimetals suffer any essential change from heat so long as the air is excluded, there are several bodies of both classes w.ch by the joint action of air & fire are gradually deprived of their metallic appearance & qualities & converted into a powdery or vitreous substance called Calx or Scoria, hence arises a further distribution into imperfect or those which are susceptible of those changes: and perfect or those w.ch suffer none.x x. neum: p46

The perfect metals, Gold & Silver suffer no damage or change whatever by the most violent & lasting action of the fire — The imperfect metals by the force of fire may be deprived of their phlogiston & consequently of their metallic form; there are 4 viz.t Lead Tin Copper & Iron. x

The ancients only took notice of 4 Semimetals viz. Quicksilver, Antimony, Zinc, & Bismuth to w.ch list the moderns have added Platina Cobalt & Nikil

Gold (the Sol & rex metallorum of the chymists) is a yellow metal scarce at all elastic or sonorous, very soft & flexible, the most ductile of all metallic Substances, & the most ponderous of all natural bodies** being to water above 19 to one

x last paragraph from Neum. vol i p:47
x Newman's Chemistry ~~p:22~~ vol: p:47

Silver (Luna Diana &c.) is the most perfect ductile & fixed in the fire of all metals after Gold, but has this one advantage over Gold that of being alittle harder, which makes it more sonorous than Gold. Newman vol 1 p 67.

Lead (Saturn) is a pale livid white metal; soon loosing its brightness in the air & contracting a blackish or greyish colour; very soft & flexible, unelastic & unsonorous; the heaviest of all metallic bodies but Gold Quicksilver (& Platina), being upwards of 11 times heavier than an equal bulk of water.*

Tin (Jupiter) is a white silver coloured metal, not at all sonorous or elastic alittle harder than Lead, softer than any other of the metals, very ductile so as to beat into thin leaves. It is the lightest of all the malleable metals, being little more than seven times heavier than an equal bulk of water *

Copper (Venus) is a reddish metal easily tarnishing in a moist air & contracting a green or a bluish green rust. It is the most elastic & sonorous of all the metals & the hardest of all but Iron. It spreads difficultly under the hammer, but may be extended to a great degree, drawn into fine wire and beat into thin leaves. Its spec: gravity to water nearly as 9 to 1 *

Iron (Mars) is a greyish metal soon tarnishing in the air to a dusky black hue, & in no long time contracting a

* Newman p: 78 * do p: 124 * do: p: 89

a yellowish or reddish cast. It is the most sonorous of the metals except Copper. It is lighter than Copper but heavier than Tin. It is the only metallic body wh. attracts or is attracted by the magnet one of its own Ores.+

Semimetals

Quicksilver, Mercury, is a fluid metallic Substance not moistening the hands, perfectly opake of a bright Silver Colour resembling Lead or Tin when melted; entirely void of taste & smell; extremely divisible; not congealable except in a very great degree of cold.*

Antimony is a blackish mineral Substance staining the hands, full of long shining striae like needles, is hard brittle & considerably heavy.+ By this is meant the Semimetal or regulus separated from its ore, different from crude Antimony as it is called wh. is its ore & sold in the Shops under the name of common or crude Antimony.

Zinc is a white semi-metal inclining a little to bluish. It is hard & sonorous, & less brittle than any other of the semimetals. Its specific gravity is somewhat near to Tin. ◻

Bismuth or Tin Glass is a sparkling white Semimetal very ponderous, hard & sonorous, extremely brittle, without any degree of malleability, falling into pieces under the hammer, & reducible by triture into fine powder △

+ 1. Newman p: ~~100~~ 100 * Id: p: 133 * Id: p: 1[illegible]3 ◻ Id: p: 171 △ Id: p: 17[illegible]

White Arsenic or Arsenic strictly so called is as moderately is a moderately heavy compact hard brittle concrete, of a crystalline or vitreous appearance, gradually changing to a milky hue on being exposed to the air like that of porcelaine & at length to the opake whiteness of white Enamel.*

Platina this semimetal is said to be found in the gold mines of the Spanish West-Indies, has but lately been known in Europe. It was carried over to Europe in small white grains mixed with a ferruginous sand & some other foreign matters It is called by the Spaniards Platina (a diminution of Plata Silver) probably from its color for in this respect it greatly resembles Silver tho' in others it comes nearer to Gold.*

Cobalt The regulus of cobalt (which is a singular Ore of Arsenic) is a brittle Semimetal fusible in a moderate red heat nearly the same as that in which Silver melts, on continuing the fire it changes slowly into a blackish calx which urged with a very violent fire runs at length into a bluish black Glass □

Nickel is a white semimetal when compared with Silver inclining a little to reddish of color texture very bright. Its spec: gravity to that of water is as 8½ to 1 *

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* 1: Newman p214 — * Ib: p: 63. — * Ib: p ~~#~~ 234

□ Ib: p: ~~#~~ 233

Ores are metallic matters such as are found in the bowels of the earth blended with Sulphur or arsenic or both. In this state of Ores they are often lodged in stones sand or earth this bed or place in wh. these Ores are lodged is termed Matrix.

But when these ores are combined with other matter in such a proportion as not to be separated wh. advantage & profit these compounds are called Pyrites & Marcasites especially if sulphur or arsenic ~~a principal~~ if be predominant therein wh. often happens — Macq: vol:1 p 145

4 Earthy Substances

All earths may be reduced to 3 heads or classes, viz. absorbent, crystalline & argillaceous wh. are easily distinguishable from one another —

Absorbent Earths unite wh. acids ~~and~~ this union is accompanied with effervescence; they are friable in the fire; are so called on acct. of their effervescing with acids.

Crystalline Earths are stony bodies of great hardness, capable of striking fire wh. steel; by vehement heat & extinction in water becoming brittle friable or powdery: not acted upon in the least by acids either in their natural state or when calcined. (a)

(a) Neuman v:1 p. 3 — (a) Neumann p Do —

Argillaceous Earths are commonly found in a dry friable state, but mixt with water form a tenacious paste or soft stone wh. becomes hard by burning, corroded by strong action in the concentrated mineral acids, but not acted on by moderate digestion.(b) Newman vol. 1 p30.

Those absorbent earths that may be changed into quicklime by the action of the fire are called calcarious & from that operation is taken the terms of calx & calcination whether we speak of earths or metals: It has been imagined that q: lime is no other way produced than from an absorbent earth having suff. action of the fire, but it may by being deprived of its fixd air by other means. The crystalline earths have been called vitrescent Earths but by themselves are no more vitrescible than quicklime or any other earth as proved by Mr Potts Experiment.

Though flint by itself absolutely resists the most vehem.t heat & quicklime equally resists it, yet a mixture of the two run easily into Glass

These crystalline Earths by the addition of an alkaline are readily converted into Glass more transparent than the other earths hence are called sometimes vitrescentes vitrifiable earths to distinguish them from the others wh. however may be convert. into a glass but wh. is less transparent.

It is the opinion of many that stones are Earths cemented together in large masses or rather earths are Stones

crumbled down.

~~Reaumur~~ distinguishes stones from absorbent earths in this manner viz: he observes that ~~if~~ a stone put into water will admit no more water than will enter into its interstices but the bulk of earths encreases very considerably, each particle swelling like a spunge. To observe such a swelling in the crystalline earths would require a very nice observation, but this intumescence becomes very manifest in absorb.t earths

Some have added gypseous & talky bodies to the list of Earths but they are not earths. we know their true composition viz: an acid & an earth i.e. they are saline subst. but are soluble in water only in a small quantity.

The gypseous bodies are distinguishable from crystalline substances in not being so hard as to strike fire with Steel, they differ from argillaceous bodies in being friable after suffer.g the action of the fire & may be crumbled to powder. this powder by the addition of water alone will instantly concrete into a hard mass — It is the matter from w.ch stucco work is made — It is a selenitic salt being made up of the vitriolic acid & calcareous earth. Quicklime differs from it in this respect that it does not with water alone concrete into a hard substance

The following marks distinguish talky bodies — they are unchangeable in the fire, at least to a great degree; they are therefore incombustible; they are of a fibrous or foliaceous structure; they are not friable or ductile with water as the absorb.t earths, nor are they so hard as to strike fire with crystalline earths.

Water when in a simple state is transparent whilst fluid & uninflammable — it is the basis of all fluids, & is an universal fluid, distributed in abundance thro' all the kingdoms of nature, but referr'd most properly to the fossil kingdom from its being collected in such immense reservoirs in the Earth.

Water is not a simple element however it may appear so. But when it is not so much impregnated with any mineral or fossil body as to be unfit for the common offices of life or to give any particular taste it is then called common water.

But when it is so far impregnated with those substances as to have a particular taste or to be unfit for the common offices of life it is then called mineral water.

Fourcroy makes 4 Classes of mineral Waters
1 Acidulous Waters
2 Saline Waters
3 Sulphureous Waters
4 Ferrugineous Waters

Part 2d.

Of the operations of chymistry

The qualities of bodies are the objects of chymistry & the operation of chymistry are the means by which the qualities of bodies are changed, some destroyed & other new ones produced

The changes of the qualities of bodies which are the effect of chymistry are all of them produced by Combination or Separation.

All the changes of the several qualities of bodies by combination seem to depend on an attraction of discreet bodies, whereby the small parts of bodies seem determined to approach nearer each other, or in a certain point of contiguity to cohere together, so that whenever a chymist is said to unite bodies it is only meant that he places those bodies in such circumstances that according to the laws of nature the combination will takes place

A chymical separation of the parts of bodies or a resolution of them into their constituent principles is the disjunction of concrete bodies, which takes place when the chymist applys to a comp^d. body in proper circumstances another body which has a greater attraction to one part of the compoun

× See M.S. Notes

than already subsists between the constituent parts of that first body, or when he applys such a degree of heat as to destroy the cohesion. The first depends on elective attractn: the last is oweing to the action of the fire.

+ It is the nature of Fire to penetrate into all bodies, to place their parts at a greater distance from each other: this in solid bodies is called expansion of bodies by heat. If by this medium the parts of bodies are so entirely separated as to loose all cohesion, the more light & volatile part is carried off by the action of the fire & is dissipated in the air. When this separation is only effected so far as to diminish the cohesion very much, but they still adhere to one another in such sort that the parts easily recede on the least force applyd: this state of the body by means of fire is called fusion, as the same condition of bodies when it takes place without fire or in the common temperature of the atmosphere is called fluidity, but when a solid body becomes fluid by the addition of a fluid body it is termd Solution.

When the heat of the fire is so far increased as to destroy the cohesion a further degree of it places the parts of the body at so great a distance from each other as to be specifically lighter than

Of Fluidity

There are various opinions concerning the ~~nature~~ cause of fluidity - The chymical philosophers have pitched upon water as the cause of it, but this is easily refuted, for tho water is found in most bodies yet we are not to impute their fluidity to this alone wh. depends on combination as water itself is solid with a degree of cold under 30.° of Farenheits Thermometer.

The corpuscularians therefore find room for their doctr. they impute it to the sphericity of its globules a theory as false as the other, & those fond of chymd. reasoning triumph in shewing what a weak doctrine the corpusculanians have substituted instead of theirs. & in fact its not probable that the figure of the particles of water at 33.° is chang'd from what it was at 32.° yet in one degree it is solid, in the other fluid.

Fluidity then must be a particular relation between bodies & fire

But how bodies require different degrees of heat to render them fluid is a Theory yet to be solved.

× Dr. Cullen thinks all bodies may be rendered fluid & consequently that fluidity is not a particular but a general property of bodies or matter. Others on a supposition that bodies become solid by the privation of Heat imagine that Solidity is their natural state

than the air, whence they ascend either in form of smoke, or if the body was first rendered fluid or capable of fusion they ascend in a state of Vapor; this is owing to the volatility of bodies & is called exhalation. In this state of Vapor the particles of the body repel each other, so that fire lessens the attraction in bodies so much as at length to change their attraction into a repellent power; hence we see that the effects of fire on all bodies are three fold i.e. from the heat of the fire all bodies pass thro' the three stages successfully of Expansion, fusion & exhalation or evaporation — Inflamation being only a mode of exhalation

Some bodies can't be changed into a state of fluidity by any heat we can give them; others may be made fluid but cant be reduced into vapor by any art we know, altho we believe they are all capable of passing thro' the three stages above mentioned by powers in nature if we knew how to apply them; some we know are capable of fusion by burning glasses or fluxes we did not formerly know, some others we may perhaps be better acquainted with hereafter ×

As the action of the fire lessens the cohesion in the parts of a body, it is employed both as a separating operation & to favour the combination of other bodies

The separation of different bodies from one another by means of fire is

is owing to their being either fusible or volatile in different degrees of Heat, of which we take advantage in order to procure a disunion or separation: thus if to 2 bodies united such a heat be apply'd as will volatilize the most volatile or fuse the most fusible & never be carryed to such a hight as to fuse the least fusible or volatilize the least volatile a separation will be made; & this principle of bodies being volatile or fusible by diff.t degrees of heat is the foundation of all chymical separations by the action of fire.

Examp.t: Suppose Lead & Copper were united together in a mass, both of these are fusible by fire but require very different degrees of heat for that purpose; the lead being fusible in a very small Heat, but the Copper requires a very great Heat to fuse it; If then only such a degree of heat be apply'd as will fuse the Lead, the Copper will not be changed but the melted lead will be separated from & run out of the copper leaving it alone. This operation is often practised in separating Metals from one another which may be confounded together in the same Ore.

In like manner if water & volat: alkali be united together: as they require different degrees of heat to be chang'd into a state of vapor, we can take advantage of this property to separate

× Sales nil agunt nisi voluti

separate them one from another by Exhalation, if we apply such a degree of heat as will volatilize the most volatile only of the Alkali w.ch will forsake the water by such a heat & rise in vapors; these vapors being collected into a proper receiver are condensed again by means of the cold into a fluid state.

On this principle we practise distillation for the sake of separating wine or Spirit from water, this Spirit may be impregnated with essential oils or the aromatic parts of plants w.ch consist chiefly in their essential oil & thus affords us the means of obtaining many agreeable simple & cordial waters by distillation for the use of medicine.

The action of the fire employ'd in chymistry always produces a state of fluidity or exhalation & thus separates bodies or favors a new combination. Elective attraction requires likewise a state of fluidity in one or both bodies either by Solution or fusion before it can take place ×

So that if we include Condensation & rarefaction under this head, we may truly say that all operations in chymistry whether of separation or combination may be reduced to three classes of Solution, fusion, & exhalation.

These comprehend under them all the various methods of altering the qualities of bodies, of resolving bodies into their constituent parts, or of uniting them together so as to form new productions ~

1.st Of Solution

When any solid body immersed in a fluid is divided into very subtile parts & universally dispers'd thro' the whole of it so as to remain uniformly conjoin'd & suspended with the fluid. so as to form one seemingly homogeneous fluid mass we call this operation Solution

The any solid body thrown into the fluid is call'd a Solvend. The fluid supposed to be the dividing substance is called Solvent or more com.ly the Menstruum

The term of menstruum & Solvend are easily understood when we ~~apply~~ only unite a fluid with a solid body, but the chymists frequently employ the term menstruum & Solvend even when they unite two fluids by mixture

If of 2 fluids employ'd the smaller is universally dispersed thro' the larger so as to remain uniformly conjoin'd with it & both together form a seemingly homogeneous mass the larger quantity of fluid to wh.ch the other is added is call'd y.e menstruum, & the smaller the Solvend.

When they are employ'd in equal quantities either of them may often is term'd menstruum or solvend indiscriminately however when the terms are respectively apply'd we must always confine ourselves to the same precise Idea to avoid confusion: but in fact there are means of determining precisely wh. is the menstruum properly & which the solvend, but the consideration of it does not come in here.

Solution is opposed on one hand to mechanical diffusion, & on the other hand to mixture. Clay dispers'd in water per minima is term'd mechanical diffusion. The union of bodies so as to form a tertium quid is term'd chemical mixture. Salt dissolved in water is termed solution the body remaining in solutis principiis.

Both in solution & mixture there happens a saturation; thus we have it not in our power to dissolve salt in water to any quantity at pleasure; we cannot dissolve more salt in water than about ⅓ of the weight of the water after wh. all the salt that is added rem.s undissolved. In this instance the solution is limited by the power of the menstruum or nature of the solvend thus when the water has dissolved all the salt it is capable of holding in a fluid state we say it is a saturated solution & call this the point of saturation.

There is another kind of saturation which is termed a

turation of mixture which relates to the exact proportion in which bodies will combine by mixture & wch. they cannot exceed thus a certain portion of alkali will unite with a determinate quantity of a particular acid & form a neutral Salt, in this state we see there is a Saturation wch. will not admit of union with any quantity more either acid or Alkali alone

Chymical solution differs from mixture in not having a change produced in consequence of union in the sensible qualities of the bodies thus united except in as far as a change arises from the diffce. of consistence in the form of bodies, i Salt dissolved in water is the same Salt it was before & has the same general properties. The same may be said in making of punch, the principles of each body entering into the composition of the punch remain the same tho' blended as Sower Sweet &c:

But mixture produces a tertium quid, the mixt body having new properties different from those of its constituent principles — as in neutral Salts, Hepar Sulphuris &c:

Having thus explain'd the nature of Solution, fusion & Exhalation, & shewn in some instances how they are employed in producing changes in bodies, & having explain'd what is meant by menstruum & Solvend we are in a somewhat better condition to speak of the different kinds of attraction

There are 5 kinds of attraction known in nature. The first is that of gravitation by w.^c all bodies belonging to this terraqueous globe have a tendency to approach the Earth's Centre. The 2^d. is that between the Load stone & Iron & is called the attraction of magnetism. The third is the attraction of Electrics. These all agree in this that the attraction takes place when the bodies are at some distance from each other. The 4^th. is the attraction of Cohesion w.^h takes place when the part of bodies are in a certain point of contiguity & the 5^th. is Electric attraction of w.^c. —

[em]ploy'd in chymistry in order to produce changes in bodies
[wh]ich we have spoke in a general manner. This is a
[sub]ject of the greatest importance in chymistry & merits
[th]e utmost attention.

Of Attraction

Attraction is that determined law of nature or power by which bodies or parts of bodies in proper circumstan: [a]pproach to each other; or being in a certain point of [co]ntiguity cohere together & form a combination.

Attraction as employ'd in chymistry is either [ab]solute or relative

When two bodies apply'd to each other will unite so as to form a combination & give a new production it is called attraction in general.

when a body as water which shews a repugnancy to, or will not unite with another as oil, will unite w.th a third as alcohol this is called elective attraction simply or absolute elective attraction

But when one body in respect o two others will unite with either separately, but more readily w.th one than another & in consequence of this greater readiness to unite with the 3.d body (w.ch is called (affinity) will not only prevent its being attached to the second, but if the
first

× Or we may thus demonstrate it diagramatically

Cases of double elective attraction

Case 1st	Corros: subl:	mur: acid mercury	nitr: acid Silver	Sep^n by dbl: el: Sing^l el:
Case 2d	Comm^n: Salt	mur: acid fixt: alk:	nitr acid Silver	. . . d^o
Case 3d:	Vitr: Tartar	vitr: acid fixt alk:	nitr acid Silver	Sim: doub: elect: att^n when single elect: att: can't ap^y
Case 4th:	Vitr: Ammon:	vitr: acid vol: alk:	veg: acid fixt alk:	tart: regen: veg: fixt

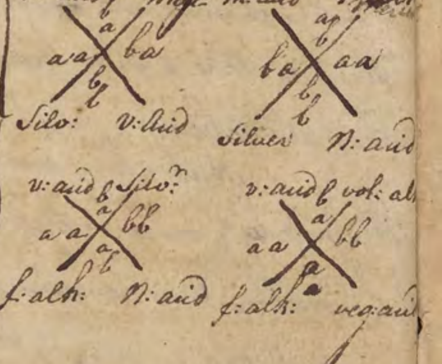
Case 4th convert^d to case 3d.

vitr: tartar	vitr: acid fixt alk.	veg: acid vol: alk:

The three first cases converted into one

mur: acid mercury	nitr: acid Silver
mur: acid fixt alk:	nitr: acid Silver
vitr acid fixt: alk:	nitr: acid Silver

Diagrams



first is already united with the second will separate the first from the second & unite itself with the first this is called relative elective attraction & will take place when the bodies are put in proper circumstances, i.e. in fluidity.

× When the body A unites with B. it is called Attraction. If A will not unite with B, but will with C it is called Elective attraction absolute. If A will unite with B & also with C; & if A, B, being joined together & C applied, A leaves B & joins C it is called relative Elective attraction.

On this is founded many curious operations in Chemistry.

All these instances we have yet given are of single elective attraction, where there are only three bodies which are employed viz. a single body applied to a mixt body in which we have a resolution of one compound & a new compound formed. a separation first taking place & then a new combination.

This makes it ridiculous for chemists to divide operations so as to treat of them distinctly as they are employed to separate or combine since both these effects take place in one & the same operation.

But we are not confined in Chemistry to employ one single body to produce a change on a mixt; we may & often are obliged to make use of mixts in the application of which to one another a double resolution takes place & a double combination whence it is called double Elective attraction.

This double elective attraction admits of

Fourcroy calls Chemical Attraction by the name of Affinity. It may take place between bodies of a similar nature or between those of a different nature. The first he calls the Affinity of Aggregation, the second the Affinity of Composition. Of the last he establishes 10 Laws or rules. It is either single or double.

four different cases which we shall here endeavour to explain & illustrate.

1st When the menstruums in both of the mixts are employed as the middle term of comparison, & each of the menstrua have a greater affinity with the solvends of the other mixts than with their own respectively. Then the case may be thus stated.

mur: acid ╲╱ nitr acid } The dart denotes the
mercury ← → silver } attraction, the tail of the dart shows the middle term of comparison which should first be mentioned & compared with the body to which the dart points & then compare the same middle term from which the dart proceeds with the body wherewith this middle term of comparison is already combined.

In case the 2d we may make the two solvends the middle terms of comparison.

In case the 3d both the menstruum & solvend of either mixt are the middle terms of comparison, this is a true instance of that double elective attraction in which the separation cannot be effected by one principle of the mixt alone as in the two preceding cases; for a body as the nitrous acid w.c of itself cannot decompose the compound consisting of two principles viz: vitriolic acid & fixed alkali because they have a greater affinity with each other than it has with either of them, becomes capable of separating the two by uniting with one of them viz: fixed alkali when it is itself combined

with another body as Silver having a degree of affinity with the other one viz: vitriolic acid sufficient to compensate the defect of attraction between the nitrous acid and fixed alkali.

In the 4th case the menstruum of one of the mixt bodies is made one of the middle terms of comparison & the solvends of the other mixt is made the other middle term of comparison.

In setting about to obtain new productions by double elective attraction it is our business to find out such a body to operate with whose constituent parts, either menstruum solvend or both have a greater elective attraction to either the menstruum solvend or both of the constituent principles of the body to be operated upon.

So we might have observed in working with single elective attractions. All we have to do is to find a single body which has a greater attraction to either of the bodies already united together than than they have with one another & these differ according as we wish to obtain the menstruum or solvend in a separate state, e.g. In the case of obtaining the nitrous acid from nitre by means of the vitriolic acid or the fixed alkali by Phlogiston.

The two first cases are convertible into the third. In all three the darts may be placed one way i.e. we may employ the menstruum of one of the mixts & solvend of the same as the middle terms of comparison, we must do so in the third case necessarily as it is

convertible into the 1st & 2d cases.
In the two first cases each of the ingredients in one of the mixts i.e. both menstruum & solvend have a greater attraction to the solvend & menstruum of the other mixt than with the solvend & menstruum they are already combined with; & moreover in the opposite mixt either the menstruum or solvend have a greater attraction to the solvend & menstruum of the other mixt than with the menstruum or solvend of its own.
But in case the 3d. altho! both the menstruum & solvend of one mixt have a greater attraction to the solvend & menstruum of the other than to the solvend & menstruum it is already combined with yet we cant go farther & say that in the opposite mixt either the menstruum have an equal attraction
In the fourth case double elective attraction does not take place without heat
From the view we have given it is evident that bodies may be separated from each other either by fire or elective attraction; thus if Camphor be dissolved in Spt. Vini it may be separated either by fire or by elective attraction. The fire is employed preferably if we want to separate the spirit but elective attraction if we want the Camphor separate.

Solution No. 1 —

The suspension of a solid body in a fluid depends on the general property of matter viz. the surface of the body suspended in the fluid being so much extended as to be app. throughout the liquor & remain in contact with every particle, & the specific gravity of the two bodies not differing so much as to occasion a subsiding; this is called mechanical Solution or diffusion.

Chymical Solution depends upon particular properties i.e. a certain relation affinity or particular attraction which disposes the menstruum & solvend to combine together so as to remain connected without any regard to their spec: gravity

Thus water will form this affinity wth alcohol & be dissolved in it, but will not unite in like manner wth oil. If by means of agitation Oil & Water seem for a mom: to unite, this state is called diffusion or mechanical Solution wh. will always be made to take place between a solid & a fluid when a true chymical Solution does not take place.

Let us now consider a little what relates to the practice of Solution:—

In the practice of Solution the combination of the Solid & fluid is assisted.

1.st By the division of the Solvend
2.dly By agitation of the vessel
3.dly By the application of heat
4.dly By the application of Air

As to the 1.st The division of the Solvend

Philosophers have thought that the attraction of bodies is always cæteris paribus in proportion to the quantity of matter, the number of parts, & the increase of surface, which allows better of all the parts coming into a more speedy contact. It is manifest an advantage arises therefore from the division of the solvend into small parts

The body to be dissolved being reduced into powder will be easier attracted by the menstruum as the parts become very small & surface of application large

It is common to recommend the addition of the Solvend by little & little, should the whole be put in at once it may fall to the bottom without allowing time for Solution & the lower part of the menstruum in contact with the Solvend will be saturated forming a kind of partition between

+ e.g. common Salt thrown into water

the two on this account +

There are diff.t methods in w.h bodies are divided in order to render them more soluble — & this is applic.ble to pharmacy

1.st Division of the Solvend may be performed by mechanical impulses; as when the bodies are hard dry & friable triture, levigation & elutriation may be employ'd. but if hard & not friable then limation & incision are used. In trituration of bodies the pestle & mortar are the most common Instruments: thus the body may be reduced to a powder seemingly pretty fine; but by means of a Search or Sieve the coarser part is got separate from the finer & is returned to the mortar for further comminution.

The finer powder thus obtain'd has not been thought sufficiently fine enough for some purposes — therefore

Levigation has been used (i.e) rubbing the powder between two hard bodies having polished surfaces as on a common marble slab, or porphyry with another stone made fit to take hold off & to rub over ~~& to rub over~~ the powder to be levigated on the marble with a little water to moisten the body w.ch is thought to favour the levigation.

x Levigation being commonly made upon a Slab of Porphyry this process is sometimes called Porphyrization.

by this means crabs eyes & testaceous powders may be reduced to a fine powder almost impalpable.×

Sometimes the rubbing a somewhat softer body as Calomel & Cinnabar ~~[illegible]~~ in a marble or Glass mortar with a pestle ~~to~~ an impalpable powder has been called Levigation. The finest powder is obtained by Elutriation i.e. committing the powder obtained as fine as may be with pestle & mortar into water or other fluid that will not alter its texture or weaken its virtues & agitated for some time to diffuse it perfectly, then letting the heavier coarser parts subside to the bottom - what remains suspended will be exceedingly fine; decant it & lett it subside for some days & the fine powder may be got separate.

This is only applicable to such bodies as the water will not dissolve such as hard stony or gritty bodies &c.

Limation means the same as filing, & is often employed for the division of metals into small particles.

Incision is the cutting of bodies into small pieces whether by means of knife or scissars or otherwise.

Granulation be employed for reducing of metals

to grains or powder founded on the property it has of being converted to powder very easily by ~~triture~~ ith pestle & mortar; if heat be apply'd to the degree of fusion, at the moment when it is passing from a solid to a fluid form by fusion, or from fusion to a solid form; thus we get the powdered tin & other metallic substances by granulation.

Similar is the operation whereby nitre, or gum powder is reduced to a powder i.e. when it has been dissolved & is evaporated nearly to dryness stirring it about then with a spatula will reduce it to powder.

<u>Chymical operations</u> for dividing bodies are chiefly — <u>Ignition & Extinction</u>, thus crystalline Earths being made red hot in the fire, by suddenly exposing them to cold are broke down very finely & by similar treatment glass may be cut by alone without the assistance of a diamond, dip a thread in sulphur, set it on fire & apply it burning to the glass, then suddenly apply cold to it & it will crack & break off as you desire; likewise by means of burning charcoal or a hot iron glass may be cut.

<u>Calcination</u> is when a body may be reduced to powder by the heat of fire or burning without exposition to the cold in order to effect it as in calcining of Hartshorn &c.

Amalgamation is often employ'd & may be used to render metals friable; heat a metal, pour quicksilver on it & spread it with a spatula it will incorporate with the metal and render it brittle.

By rubbing mercurial ointment on a gold ring or watch it will render it friable so that watch may be broke by a fall; or a gold ring may be thus easily got off from a finger much swelled by it when a mortification is feared or a saw cannot be apply'd

Dr. Cullen was call'd to a young lady in this condition & by rubbing a quantity of the ointment on the ring it became friable in a short time & broke

2.dly Agitation of the vessel.

The use of agitation in order to render the solution perfect may be rendered visible; if to a vial of water colored with cochineal you add a quantity of ~~water~~ alcohol very cautiously either by trickling as it were, by drops down the side of the vial without the least agitation & it will remain on the top of the colored water without mixing with it in the least as may be seen several days after. In a week after if you shake the vial the alcohol will unite with the water & never will be separated again without some chymical operation for that purpose is

If salt be thrown in small quantity into a glass of water & suffered to remain for several days at least great part of it will be indissolved, but if it be agitated sometimes the solution will be quickly expedited & be very perfect.

Without such agitation the lower part of the menstruum becomes saturated & forms a partition between the remaining Salt & water.

Some bodies are apt to become viscid before solution & will remain cemented for a long time without the assistance of agitation as procured by ~~ebullition~~ water

On this account sand is often mixed wth viscid bodies to be dissolved, & agitation employed till the menstruum has had time to exert its action fully upon the Solvend.

The 3d. mean of assisting Solution is heat

This by acting on the menstruum encreases the power of solution as in the quantity of nitre, Crem: Tartar and several neutral salts to be dissolved in a given portion of water. But frequently it acts on the solvend or matter to be dissolved & injures it much or wholly destroys the qualities wh. preexisted in the subject & for which the solution was wholly intended.

A slight solution of Gentian is a wholesome & pleasant bitter, but if by means of long digestion, decoction, or great heat the solution becomes a nauseous & hurtful medicine.

Rules to be observed in the application of heat.

The degree of heat must be proportioned to the menstruum & solvend.

1st By the quantity of extract wh. it is intended to procure — & the quality. If we intend to extract only the most soluble part we must not apply such a heat as will dissolve likewise the more insoluble part least this should change its virtue or injure it.

2.d If the whole of the solvend is to be obtained but in diff.t degrees according to the nature of the successive solutions we would make, we are to consider the firmness of texture of the different solvends & apply heat accordingly, & not waste fuel or use it unnecessarily.

3.d When we operate in open vessels we are to consider the greater or less volatility of the menstruum or solvend; for instance if Spirit of wine or any Spirit be app.d to a body to obtain its virtues & we assist this with heat we should not encrease it to such a degree as to dissipate the Sp.t St. we want impregnated with the Solvend.

4th

Solution No. 2

4th If we propose to retain the present qualities of the subject we must avoid applying such a heat as to give an empyreuma wch not only destroys the virtues we wish for but may give certain qualities which we should be glad to avoid.

The 4th Assistance to Solution is the application of Air or extraction of Air.

All bodies have more or less fixed air in them, as water being put under an exhausted receiver air comes out ~~air~~ bubbles & in being let loose opens the parts of bodies

The Air itself likewise acts as a menstruum in dissolving bodies, from whence they become deliquescent

Air is sometimes united to bodies in consequence of an elective attraction, this often prevents other bodies from joining till the Air is extricated, then a combination will take place

This fixed is different, from common Air, it never issues out from a body without the common air receives it as a menstruum.

By its pressure on the surface of the liquor it may promote solution, for air is necessary in the solution of

of many bodies.

This is evident in the solution of copper by means of volatile alkali w.ch if put together in close vessels for a whole month would not unite but upon opening so as to favour the application of air they will unite immediately & a beautiful blue colour will ensue in consequence of this solution as in the liquor saphirina

If much water be put into a copper vessel no mark of corrosion is seen only where the air comes in contact with the surface of the water. The same happens when sal ammoniac is added or such substances as is known to corrode copper, the corrosion only takes place at the ring round the copper vessel when the surface touches it & the contact of the air conspires.

The best way to keep copper vessels from rust is to keep them full of water, for the air rusts them, especially when there is a small quantity of water at the bottom.

As there is air in all water so there is water in all air even the dryest w.ch some bodies will attract from air so as to run down by deliquium

Solution according to certain differences in the practice is named

Maceration which is a soaking ingredients in water or other fluid to soften them & draw out their virtues. Lemery defines maceration to be a sort of digestion confined to thick substances, thus when Rose leaves are put into fat to make oil of roses this mixture is for some days exposed to the sun in order to macerate that the qualities of the roses may be the better conveyed to the fat

Infusion is a method of obtaining by solution the virtues of plants by steeping them in a hot or cold liquid. They are made by pouring water whether hot or cold or any other menstruum on the substance whose virtues we would extract; but in cold menstruum where the more subtile parts afford the principal virtues & flavour is committed.

If strong infusions are wanted they may be obtained by Cohobation, that is frequently pouring the same liquor on fresh ingredients by which means the virtues of simples may be procured unaltered yet concentrated so much that a few spoonfuls of the liquor shall contain surprizing virtues. Nor can a valuable essence of violets lillies or any

flower of a fine odoriferous spirit be procured by heat, as it may in the manner aforesaid.

Decoction is employ'd for solution. This practis'd on simples, roots, plants, &c: to extract their medicinal virtues when the liquor is kept at a boiling point it is called Decoction —

Digestion is employ'd for the same purpose but in this the heat is kept at one & the same height but below the boiling point

Circulation is an operation whereby the same vapor raised by fire falls back to be returned & distilled several times — It is performed in a single vessel stopped at top & called a pellican, or in a double vessel w. consists of two pieces luted on each other the lower to contain the liquor. — It is performed by the heat of a lamp, of ashes or sand. or of a common furnace.

Deliquescence is when a body as an alkaline salt attracts moisture from the air which will gradually dissolve it into a fluid form.

Amalgamation is an operation of chemistry for mixing quicksilver with some metal by fusion or igniting the metal & adding mercury to it upon which they mutually attract & incorporate with each other

It is the foundation of the art of gilding both in gold & silver, . metals by this art may be mixed, confounded and variety blended with one another.

In the practice of Solution it is commonly proper to avoid effervescence & dissipation —

1.st The inconvenience of effervescence is, that the fumes are almost always of anoxious quality & might injure the operator, & often inflammable & so dangerous to the neighbourhood.

It is a curious fact to observe that if to vitriolic acid in its most concentrated form be added a piece of iron, it will remain in the bottom untouch'd, but if the vitriolic acid be diluted with water or iron be put into a diluted vitriolic acid it will then dissolve readily —

An experiment might easily be made to illustrate both the danger from inflammability of a fluid & the noxious quality of the fumes.

Add filings of iron to the vitr: acid the effervescence is but just sensible; if the fumes be incautiously taken in with the breath it will greatly injure the person; & if the flame of a piece of burning paper or a candle is brought so close as to touch it, it will burst forth into a flame with an explosion like the crack of a pistol.

an effervescence that the vessel however high will not be sufficient to contain them but the whole will be dissipated & lost in fumes.

This seems to be owing to the concurrent action of the air as a means of promoting the solution of bodies.

we know that where matters would be dissipated upon union, if exposed at the same time to the action of the air if this union could be safely effected in a close vessel we should prevent the effervescence & dissipation, but there is often danger, if the vessels are but thin, of their being broke in the operation

The interposition of some proper body between the two bodies to be united & the external air is a good contrivance of a <u>french</u> chemist to prevent dissipation.

Then if we were desirous of dissolving steel in the nitrous acid we might take a long vial like an hungary vial, then put in the acid of nitre & cover it some thickness with oil put in little plates of steel or Iron first dipped in spirit of wine to prevent them adhering to the oil & carrying down any part of it in its descent, the effervescence will then be very small & the air that is extricated will get into the oil & gradually through it in an insensible manner, thus if the oil is in some quantity

the dissipation & rise of noxious fumes will be greatly prevented.

When such assistances are not sufficient we have no other resource left than a chimney to carry off noxious fumes & vapours.

Solution is sometimes employ'd as a separating operation when the solvend is ~~tik~~ a mixt & the menstruum is capable of dissolving only one of the parts wh. remains suspended in the Solution. this is a resolution of the principles of that body. But when the menstruum will act upon & dissolve the whole of the substance tho' compos'd of diff. principles it's to be considered as an aggregate divided into integrant parts unless a tertium quid is produced or 3d. body of very different properties from either menstruum or solvend.

When only one part of the body is dissolved or there is more than the menstruum can take up; it may be separated by straining through a rag or sieve which will not let the gross parts pass through its pores, this operation is called Colature or Filtration.

When the fluid is suffered to remain at rest & the gross parts subside by a gentle ~~heat~~ inclination of the vessel the fluid may be poured off leaving the sediment behind this is called Decantation

Solution No. 3

The same purpose may be answered by the use of a Syphon.

Having explain'd all the terms which occur under this head, we come next to speak of the means of recovering dissolved bodies from their menstrua.

This may be done by precipitation, crystallization & Evaporation.

Precipitation is where bodies are made to fall down in any form or powder from the menstrua they are combined with by means of some other body added.

It depends upon elective attraction & the body added is named the precipitant. which has a greater attraction to the menstruum than the body already combin'd therewith, & therefore it unites with the menstruum and detaches the first solvend.

The operation is employ'd for this purpose & the body thus falling down is call'd a precipitate, this may be either the solvend or menstruum.

There are therefore 4 cases of precipitation.

1.st Of the solvend or dissolved body alone
2.d of the solvend with the precipitant

3.ly Of the menstruum alone

4.ly Of the menstruum w.th the precipitant

In the two first cases the dry body falling down is named a precipitate, magistery, or calx

An Instance of } the 1.st } If gold be dissolved in aqua regia, iron to which aqua regia has a greater attraction than it has to gold will attatch th[illegible] which from its greater specific gravity will fall to the bottom

Of the 2.d } Take a solution of Silver in nitrous acid, add to it muriatic acid, a separation is made as is evident by the milky appearance, a powder falls to the bottom w.ch is the silver united with the muriatic acid whilst the nitrous acid remains alone.

Of the 3.d } If gold be dissolved in ~~the~~ aqua regia and vitriolic aether be added this will unite with the gold & being of less specific gravity will remain at top whilst the former menstruum the aqua regia is precipitated to the bottom by itself.

Of the 4.th } If a resinous body be dissolved in spirit of wine & water added this will render the mixture turbid the resin will rise to the top & the menstruum with the body

x In the following case a precipitation happens without any elective attraction, if Gold be dissolv'd in muriatic acid & Silver in the nitrous acid & both added together the acids will form an aq: Regia w.h will dissolve the gold but the Silver has a particular attraction thus it will precipitate the gold, but as the att:n of the Silver is so small as not to keep it suspended they the Silver will also precipitate

added, the water, will occupy the lower place.

There is another instance of precipitation which may perhaps be referred to elect attraction but that is not plain. It deserves therefore to be considered by itself.

If regulus of Antimony be dissolved in acid it may be thrown down by water; But this seems to be owing rather to the water so far weakening the menstruum as not to suffer it to keep the antimony in solution than the greater affinity of water to the acid as in the case of water precipitating camphor from alcohol from the affinity between water & alcohol, for here the camphor is quite separated whereas in the former case the acid is not entirely separated from the antimony, some part still remains adhering to it & the antimony is precipitated in form of a Calx. x

Rules to be observed in precipitation.

1.st The mixture or solution is to be diluted with a quantity of water to favour the application of the body which is to be divided per minima & as it is thought, to weaken the cohesion between the menstruum & the body to be precipitated, however this be it serves to collect the body to be thrown down & gives the better opportunity of making the

addition by little & little that it may prevent effervescence & dissipation

2:dly The 2d rule therefore which regards the effervescence is to apply the precipitant by slow degrees leisurely

3:dly No more of the precipitant is to be added than what is necessary to obtain the precipitate req:d.

These rules may be illustrated in precipitating the solution of silver in nitrous acid by means of vol: alkali

Dilute the solution with a quantity of pure water.

Add volat: alkali by little & little at a time: every addition of it will occasion some effervescence, & if not made slowly the effervescing fluid would be carried over the top of the vessel, & every succeeding addition increases the same till there is a saturation

Upon continuing to add the volatile alkali a milkiness is produced & a white powder falls to the bottom

We must continue adding alkali till no more white matter is precipitated & then leave off, for by adding more volat: alkali you enable the menstruum to take up the whole of the ~~menstruum~~ precipitate again

This rule is to be very much attended to in most solutions of the metals in acids.

The matter thrown down in form of powder is called precipitate.

Magistery is a term given to the precipitate by the ancients on an erroneous supposition of this precipitate containing as it were an extract ~~mutheum~~ in parvo of the very ~~many~~ virtues of the substance precipitated.

But now the least attention to the nature of the subject shews ~~that~~ the precipitate is one of the principles of the mixt wh. formed a tertium quid & possess'd properties different from its compon.t parts

Calx is a term used to denote a precipitate wh. is often call'd so from its similar appearance to the powder obtain'd by calcination, but correct writers avoid this term, in the precipitating of gold we get it again in its pristine form.

When Silver is precipitated it is not always obtained entirely pure but often join'd with the acid in the particular form of corrosion

When metals have a portion of acid adhering to them

them, but in such a quantity as to unite ~~with~~ and suspend the metal, it is then call'd a Corrosive the solution not being compleat

Whenever we precipitate metals by means of alkalis a greater or less portion of acid adheres to & is thrown down with the precipitate & the corrosion is more mild or acrid accordingly.

This corrosion does not take place if one metal is precipitated by another, the solution being compleat

As a metal is only is more corrosive as it is less free from the adhering acid, we practice repeated washings to get them quite clear from the acid that adheres to them; the oftener this washing is repeated the more mild the precipitate becomes, & by a figurative manner of expression it is termed more sweet & this operation therefore is called Edulcoration.

× On the subty: of crystalizn: in Boerh: Ch: vol 1 p 332

Having sufficiently explain'd the nature of precipitat:n
& how it is that dissolved bodies are separated from their
menstrua by means thereof: our second step is to consider
a little the nature of crystallization, & how dissolved bodies
may be recovered & obtain'd separate from their Solvents
2. by this operation *

To understand this subject we must recall to
mind that all simple fossil salts whether existing in a liquid
or solid form as acid & alkaline Salts, Sal Gemm, fountain
Salt, Sea Salt, Borax, Nitre & Sal ammoniac are capable
of being dissolved in water, or in other words, water is
possessed of a dissolving power ~~whereby~~ which it is able to
dissolve those bodies in such a manner, that when they are
dissolved in it you will have a fluid in which the dissolved
bodies shall be so equally distributed that in every part
of the water there shall be a proportionable part of the solvend.

In the Solution however effected in this manner, there
is observed a very great & manifold diversity.

The acid salts w.ch are almost always liquid may be
dissolved in any quantity of water however small as this of

× B: Ch: p 336

oil of Vitriol will be perfectly dissolved in a drachm of water so that all the elements will be accurately divided & distributed thro' the water in an equal proportion.

But on the contrary the fossil Salts that are of a solid form will not suffer themselves to be dissolved except in a certain quantity of water & no less. — One ounce of Sal Gem requires three ounces & two drams of pure distilled rainwater to dissolve it which is in proportion as 4 to 13 when the comm.n air is 38 degrees warm — Nine drachms of pure dry Nitre requires six ounces of the same distilled water to dissolve it in the same heat. & after which you may dilute it as much further as you please, there being no end to this dilution.

This observation however must not be extended to all Semimetals, as if semimetalline particles reduced by their acid solvents into masses appearing saline might be afterwards digested & dissolved in water like Salts (& true metals).

The purest metalline part of regulus of Antimony for instance is dissolved in the Stars and of Scarlet that adheres to the corrosive Sublimate of mercury in the distillation of butter of Antimony, a person would be

be greatly disappointed on making the experiment if he should imagin that this Butter might be dissolved in water, for as soon as ever the water comes to touch it the solvent and immediately lets go the dissolved regulus, mixes itself with the water & gives you again entirely the same metallic corroded calx that lay concealed in the Butter; this rule therefore is not to be carry'd beyond its limits.

The Sollution of Salt in water is soon effected by agitation as we remarked before.

Again hot water dissolves a greater quantity of Salts (in general) than cold water, & that in proportion to the degree of heat

If you dissolve Sal Gem in boiling water (that is in 212 degrees of heat) till the water is perfectly saturated & then remove the vessel from the fire, you will observe as the water grows colder & colder it will continu.dly precipitate more & more of the Salt to the bottom.

This concretion of Salts that was before dissolved in water is called its crystallization which appears from what has been said to arise, first, from a sufficient quantity of water being wanting to dilute it, 2.dly from

the liquor being at rest in which the salt is dissolved 3.dly from cold. For these are the instruments by wch. crystallization is brought about

But in the 4th. place we observe further that the dissolving power of water operates much sooner upon one Salt than upon another. Sal Gem is sooner dissolved in the Same water than Borax; and the same quantity of water too will dissolve more of one Salt than another

5.thly & lastly where water is so perfectly saturated with one kind of Salt that if you add any more it will fall undissolved to the bottom, yet even then it will be capable of dissolving a good deal of another sort & that without letting go the former.

Saturate for instance water of a certain degree of heat with Sal Gem so that it wont dissolve the least grain more & it will nevertheless take up a small quantity of nitre, & yet the S. Gem will remain perfectly dissolved in the water as before — Nay & when it is thus saturated with those Salts it will be able to dissolve somewhat more of another which is a phenomenon

not a little curious in chemistry.

In general this separation is effected in virtue of bodies being detained in a state of solution only in consequence of the quantity of the menstruum in w.ch they are dissolved. If this quantity be lessened beyond the exact point of saturation it is exactly the same case as if more of the solvend was added than the menstruum is capable of acting upon, consequently that overproportion will assume its native form, which in salts are different figures resembling those of crystals whence that term is so much applyed to saline substances.

This change is chiefly effected by means of evaporation w.ch dissipates the menstruum whilst the solvend having less volatility remains in the same quantity as before. It depends also in a less degree on an increase of cold, for the most part, in the menstruum as another cause why a saline body dissolved in any liquor may again shew itself in a solid form: i,e, whenever the menstruum is not capable of dissolving an equall quantity

of that body in a cold as in a warm state, for hereby the point of Saturation continually varies

In order that Salts may be kept in solution or in a fluid form a certain quantity of menstruum is absolutely necessary, & that quantity varies according to the different degrees of temperature or heat & cold in the menstruum.

Suppose then that in the ordinary temperature of the atmosphere three pints of common water will dissolve lbi of Sea Salt & no more which is nearly the case, if this Salt thus dissolved be put in a proper glass vessel & placed over a lamp furnace till one half of the water be evaporated or a pint & a half, then half a pound of the salt will assume a crystalline form: by continuing the evaporation further the whole of the salt may be entirely removed. This method is what is commonly practised at salt springs & at the salt pans near the sea shore for making of salt as it is termed.

Again let it be remarked that if any quantity of nitre be dissolved in a certain proportion of water so as fully to saturate that water in a cool temperature, & then further heat be apply'd so as to make the water nearly

or quite boiling hot, an additional quantity of nitre may be dissolved therein. But on letting the water cool again so as to return to its former temperature the additional quantity of nitre which was dissolved last will be again separated from the menstruum & shoot out into crystals in the same manner as we said of the comm^n. Salt upon evaporating part of the menstruum. & in proportion to the coldness of the water will be the quantity of crystals.

By the above acc^t. we come to understand how it is that evaporation is employ'd as a separatory operation to recover dissolved bodies from their menstrua & plainly understand that crystallization is performed by diminishing the menstruum & diminishing the heat.

If equal quantities of nitre & common Salt were dissolved in a given portion of water, they might be separated from one another by alternately evaporating & cooling the menstruum - for common Sea Salt will dissolve equally well almost & nearly in the same quantity in cold water as hot, which is not the case with nitre; hence by

by first evaporating the menstruum in a certain proportion the common Salt will shoot into crystals

But when it is so far evaporated that the nitre can be no longer held in Solution let it cool with crystals may be separated whilst the comm. Salt does not send forth any more crystals.

When all the nitre thus obtaind is separated heat the menstruum again & proceed in the evaporation which will occasion more common Salt to shoot whilst the nitre remains in Solution.

When this begins to shoot again remove the Salt thus obtaind & let the nitre crystallize again by cooling the liquor as before.

By proceeding in this manner a compleat separation of the two salts may be effected.

As cold promotes the crystallization of Salts so the crystals shew themselves in the greatest plenty on the part of the vessel wh. is most exposed to the cold; as may be proved by an easy Experiment of dissolving Nitre in warm water to saturation & exposing any part to a stream of cold air or dipping any cold body in it whilst crystallizing.

Chemical vessels employ'd in solution.

1.st They should be of such a close texture as to be capable of holding their contents & not letting them pass through their pores

2.dly They should be made of such matter as is not liable to corrosion by their contents: this excludes metals on many occasions.

3.dly They should be of such a nature & quality as to bear the necessary heat of fire to be apply'd

Glass answers very well to the first requisite, as it is not freely pervious to other bodies than light. It likewise answers to the second intention of not being subject to corrosion from any menstruum we yet know of if the glass be perfect in its kind. But as glass is made up of different materials, it is more or less pure, and impure glass may be corroded by some menstrua.

Glass vessels are limited by the third rule, as we are precluded from the use of them when such a great heat is necessary to be apply'd as would melt glass

Porcelain has the advantage over glass in this that it can bear a greater heat than glass without fear of fusion, it is likewise of a close texture & not liable to corrosion. But when glass will bear the necessary heat it is to be preferred on account of its transparency whereby we can see how the operation goes on which is a very great advantage

As to the form of the retort and reciever they are nearly round with a neck allowing space for the fumes, as they are common the form is well known.

When no heat arises from the solution nor effervescence we may choose what shaped vessel we please, but when these occur we must have length of neck to permit the vapors to pass off & the solvend must be added by degrees. The ~~Matras~~ is used in this case. In common the ~~Matras or~~ Bolt Heads & Digestor are used.

No. 5

2d: Of Fusion

The fusion of bodies as we said of fluidity in general affords us an opportunity of uniting bodies together or of bringing about a separation of the parts of bodies united together into a compound or mixt.

When solid bodies are rendered fluid by the assistance of fire, for the sake of producing any changes therein, that state of fluidity thus effected is called a dry Solution.

But when a state of fluidity is produced in any solid body by means of a menstruum that is of itself fluid in the ordinary temperature of the atmosphere it is called a humid Solution.

Fusion separates by elective attraction, that is, fusion puts bodies into such circumstances that a change may take place in consequence thereof, by means of elect: attraction & a separation of parts & a new combination may be thus effected.

When to a solid comp.d body in a state of fusion, another body is added which separates one part from another by the same kind of precipitation as takes place in the separation of a dissolved body from its menstruum it

× most of the operations in Smelting are performd by this mean as in obtaining the reguline part of antemony by applying and metal to it in a state of fusion &c

is called *precipitatio fusoria*[x] as the other is named *precipitatio humida*.

Thus in the 26th table of affinities, Sulphur is considered as a menstruum that is capable of dissolving & uniting with the several substances standing under it & the affinity of each, or power of attraction is accord: to the order in which they follow one another, therefore if Sulphur be united to the regulus of Antimony produc: the ore or crude antimony of the shops, the s. regulus may be separated from it in a state of fusion & be thrown down by any of the substances wch stand above it as Silver, Tin, Lead, Copper, Iron, fix: alk: or L: lime

This precipitate or matter thrown down by this means is termed *Regulus* & is the metalline part of the compound.

The matter which is thrown upon the surface is called *Scoria*.

In the foregoing operation on crude antimony we observe on the top of the metalline precipitate a stellar appearance or a figure somewhat like an antique crown from whence the whimsical name of regulus was first given by the alchemists to the metalline part of antimony wch name since has gradually extended to the metalline parts obtained from the rest of the ores

Exp: To Separate antimony from its ore by Elective attraction. —

Take any quantity of white Iron w.ch is Iron in thin plates covered with tin: commit this to a crucible or antimon.l Horn, put it in a furnace & let it remain there till it becomes red hot; then add crude antim.y in powder stirring it about with an Iron rod after a while the scoria will rise to the top & the regulus of antimony will fall to the bottom being of greater specific gravity than the sulphur & Iron now united together by elect: attraction.

The regulus may be easily separated from the above by a small stroke or two of a hammer.

As to the form of vessels made use of in the fusion of different bodies; it differs according to the various nature of the subject to be operated upon. +see other side

In many operations of Solution & fusion the vessels may be left open at top, in others they must be covered.

It is common to cover a Crucible with a Slab or tile to prevent any thing falling in during the operation, but its more common to make use of another crucible inverted & a little smaller so as to let a little way within

x The vessels made use of in ordinary fusion & precipitation fusion are called. Crucibles; these are of diff. kinds of matter acc. to the nature of the subject to be operated upon — Sometimes they are metallic, but most commonly they are made of Earth; of wh. there are two principal kinds 1.st Earthy called German or Hessian Crucibles. 2.dly blue crucibles or black lead ones of diff.t properties from the others — the former are the cheapest — The shape of crucibles somewhat resembles a truncated cone whose base is pressed into a triangular form for the greater convenience of pouring out their contents into a mold. 'Tis with Crucibles almost as w. Glass vessels they are sooner broke by fire when thick; but other circumst. require a greater thickness.

A Test in latin patella scorificatoria is used in Scorification when the scorified matter is blown over w.th a pair of bellows, its shape is nearly like that of a cupel

the upright crucible w.ch contains the matter to be fused & allows sufficient room for the expansion of vapors rising from the body.

The management of the fusion varies according to the subject employ'd.

The rules which are to be observed that relate to the vessels are,

1.st The Crucible is to be heated gradually least if it has imbibed any moisture & be suddenly & all at once committed to the burning fuel it may crack & break

2.dly It should not be let down thro' the fewel so as to rest on the grate, least the stream of cold air rushing up thro' the ash hole should produce the same effect; to avoid this a pedestal may be employ'd for it to rest upon, as another inverted crucible or a brick.

The degree of fire that is made use of is to be varied according to the nature of the different bodies.

Both the vessel & matter (if it be a metal especially) should before the operation have any moisture drove off w.ch they may have contracted from the air or otherwise, & whilst they are placed on the fire care must be taken that no aqueous humidity

× mixt metals are separated from one another in consequence of their different degrees of fusibility, thus if Lead & Copper be combined by exposing them to a degree of heat, the lead being the most fusible melts & is removed from the Copper — this operation is called Eliquation. Antimony & Bismuth are separated from their minerals by the same operation. Trans: tom: 2. L: 219 — 233

Congelation is similar to the above tho' seemingly the reverse, as the separation depends on the different degrees of heat necessary to fuse them, or to keep them in a state of fluidity. Thus Vinegar being comp^d. of water & the acetous acid, may be separated from each other by this means, for the water is congealable by 32^d. of cold in Fahrenheits Therm^r. whereas it requires a much greater degree of cold to congeal the acid; if then you expose Vinegar to 30 degrees of cold or a little more the water congeals & the acid remains fluid & may be separated from it — this is one of the most desirable things in chemistry as by no other means can we concentrate the veg: acid without a change of its qualities —

approach them. for if a few drops of water for instance should accidentally fall into melted lead or other metal it would be thrown out of the vessel w.th great force & to the no small detriment of the operator

Sometimes a separation takes place in fused bodies in consequence of their different specific gravity the heaviest subsiding to the bottom of the vessel ×

A Conical mold is much used for this purpose that the reguline w.ch is often in a small quantity may be the more easily collected.

The one made use of commonly in separating antimony from its ore tho' compos'd of Brass or Iron yet from its shape is generally called an antimonial horn.

These vessels or molds are also directed to be made as hot as the metals themselves, in order to preserve them the longer in fusion, w.ch favors the separation the better. Chemists likewise generally grease the inside by exposing it to the flame of a lamp or candle in order that when cold it may be got out the more readily.

The fusion of metals is of two kinds, the one is common. when no other change happens than that they are reduced from a solid to a fluid state & w.ch being suffered to cool again assume the same appearance & condition as before. In the other kind of fusion there is so great a

so great a change produced by the action of the fire, that upon cooling they concrete into a different kind of mass wh. is allways the same viz. that of Glass. This change is called Vitrefaction & lays the foundation for two sorts of operations viz: Scorification & Cupellation

These operations can never be practised to advantage except on large quantities of metals at a time.

As the vitrefaction of metals is only perform'd as a separatory process in consequence of the different vitrescibility of metals, it is worth while to explain vitrefaction in all its stages, & to know what subjects are most suitable for this purpose.

Gold & Silver are not capable of vitrifying or of being converted into Glass, by the most intense heat of a furnace; whilst all the other metals, whether alone in a separate state, or join'd with Gold & Silver are capable of vitrifying by such a heat (& particularly lead) which is one of the most vitrescible of all the metals. Lead is likewise capable of promoting the vitrefaction of other metals & thereby separating them from Gold & Silver.

If Lead be put into a vessel call'd a Test & plac'd over the fire in a furnace you may percieve the following appearances.

The lead soon grows soft & melts; thin pellicles are form'd on the top wh. are then thrown towards the sides of

of the vessel, the surface of the lead appearing in the midst
thereof bright & shining like a luminous disc: the lead
will then begin to boil & emit fumes, new pellicles are form'd
one after another & successively broke & drove to the sides
of the vessel, till at length the whole mass, by little &
little, is converted into pellicles & thus into Litharge or
red lead.

The pellicles thus form'd on the surface & pushed to
the sides of the vessel are term'd Scoriæ & the operation
is named Scorification.

By urging the heat still further the pellicles
or Scoriæ are again melted & by degrees converted into
glass, this is the state of vitrifaction ×

In consequence of these properties, Gold & Silver
may be purified from other metals or heterogeneous matters
adhering to them.

Thus, if Silver be mixed with Copper it may be
separated therefrom by Scorification & Vitrification assisted
by Lead, & may also be separated from its ore — The
lead dissolving the Copper & uniting w.th the ore of Silver.

The lead then scorifies & vitrifies whatever is not
either Silver or Gold & thus the Silver is disengag'd from the
heterogeneous matters with which it was united.
The Scoriæ are sometimes blown off from the test by a pair of bellows.

* Macquer vol: 1 p. 316

* A Cupel differs little from a Test only the bottom is much thicker to receive & retain the vitrified matter in its substance & prevent its runing thro' into the fire w.ch would be inconvenient.

matters being brought to this pass, take the test w.th
pair of tongs from under the muffle & pour its whole contents
into an Iron cone first heated & greased with tallow. The
whole operation lasts about 3/4 of an hour. When all is
cold a blow with a hammer will part the regulus from the
Scoriæ; & as it is not possible how perfect soever the Scorific-
ation be, to avoid leaving a little lead containing Silver
in the Scoriæ it is proper to pulverise it, & separate therefrom
whatever extends under the hammer to be added to the regulus.

Carrying the operation to its fullest extent the vitrified
lead & what is united with it being neither Gold nor Silver
becomes so subtile as to run through the pores of the closest
vessel leaving the Gold & Silver behind in the bottom of
the vessel by themselves.

Particular vessels are appropriated to this purpose
having a flat broad surface or bottom & shallow sides like a
saucer but of a considerable thickness; these vessels are
called Cupels* & the operation performed by means of them
is called Cupellation.

It is proper to add 8 parts of Lead to one of Ore
tho' so much is not always absolutely necessary especially
when the ore is very fusible — The success of the operat.n
chiefly depends on the Scorification & therefore the addition of
more

× It is a semicylindrical vessel open at one end
at wch place the Test or Cupel is introduced & is furni
with windows thro' wch we may inspect the matter

more Lead than enough is attended with no inconvenience for, as it always promottes scorification it can never doany harm.
maqu: vol 1. 318

The previous roasting the ore is a necessary step towards facilitating the operation; the broad shape of the vessel wh exposes the metal to the air by a broad surface expedites the calcination.

The bottom of the vessel is thick to sustain the weight of the metal ~~vessel~~ & it is composd of a matter not ffusible itself, but porous that the vitrified matter may the most readily pass thro' ~~its pores~~ as the powder of burnt bones & the cupel should be large enough to contain the whole matter least by running over any part of it be lost.

The muffle is acovering to the Test, but such an one as will not hinder your seeing how the operation goes on*

Vitrified metals by the addition of inflammable substance, & particularly of Charcoal, may be melted again & thus be brot back to their metallic forms.

This operation on metals is called reduction except when perform'd on Quicksilver for then its term'd revivification.

upon this account a muffle to cover the cupel becomes necessary in order that during the calcination & vitrification going on, it may not be impeded or the metal reduc'd by means of its contact with the burning fuel.

3.d Of Exhalation

The third head of operations is known by the term of Exhalation

All those operations w.ch are employ'd to produce a change of the qualities of bodies by exhalation perform that effect in consequence of those bodies, or certain parts thereof, being convertable into a vapor by the action of the fire w.ch volatilizes them.

These operations are distinguished from one another according to the intention of the operator, as his design may be to obtain the more fixed or the more volatile parts of bodies.

According to the first intention the volatile part is drove off & wasted in a state of vapors.

According to the second the more volatile parts are collected by a proper aparatus & the first part is regarded as useless.

When the intention is to obtain the volatile parts; we confine the whole matter in close vessels that the vapors may be condensed & thus recovered separately from the fix'd parts

When the fixed parts only are design'd to be obtain'd the operation is performed in open vessels in order to drive off the volatile parts in a state of vapour.

These operations are further distinguished according as the subjects of them are fluid or Solid bodies. When they are fluid bodies the operation is term'd Evaporation but when solid it is called Ustulation

When the operation of evaporation is employ'd on the native juices of vegetables merely to drive off the thinner & more aqueous parts in order to increase the virtues thereof or to render it capable of being preserved better it is named Inspissation

But when the fluids which we expose to evaporation, besides the native juices of plants, contain somewhat of the more solid substances w.ch have been mixed with it by decoction & digestion: I say when from a Solution of this kind we drive off all the fluid part, what remains behind is called an Extract & the operation itself is term'd Extraction.

Having explain'd the terms that occur under the head of Exhalation we are next to consider the practice of it. The separation of the more volatile from the more fixed parts of bodies depends either on the action of the air or fire, or of both.

* The first effects of heat upon a solid body is to expand & remove its parts to a greater distance till at length it becom[es] fluid — further carried on it produces Vapor which we suppose to be an elastic fluid w.^ch spreads quaquaversum but being of less spec: gravity than the atmosphere: it must rise in the air from a law of hydrostatics.

* according to the diff.^t state of the atmosphere vapors arise differently

* Air as most other menstruums acts more powerfully as heated. Air also concerns, as a medium, in y.^e suspension of bodies diffused in it & not dissolved, by detaching the parts & ma[king] them rise in consequence of their diff.^t specific gravity

Understand.^g these 3 things you'll understand the rule for the conducting of Evaporation.

Rule 1.^st Evap.^n is expedited by exposing a large surface to the air.
2. The air applied is to be renewed as briskly as possible.
3. The Evaporating is to be frequently agitated.

*The action of the fire separates the parts of bodies further apart: it converts fluid bodies into vapor by the application of greater & greater degrees of heat successively from the gentlest to the most violent in appropriated vessels, so contrived as to collect what exhales from them, the principles of bodies are gradually separated from each other; the most volatile rise first, & the rest follow in order as they come to be acted upon by different degrees of heat; & this is called Distillation.

The air itself acts very powerfully on bodies as a menstruum in dissolving & taking up parts thereof as on the surface of the ocean: It is capable of saturation & acts more or less powerfully as it is further from or approaches nearer to the point of Saturation. *It is also encreased by heat & diminished by cold.

many operations cant proceed as they ought in exhausted receivers, the presence of air being necessary to carry them on. Towards the end of all operations in close vessels which are then nearly exhausted of their air the operations are generally retarded by that cause. But if any

contrivance is used whereby fresh air is let into the vessel the operation is thereby expedited very much.

Air acts more powerfully upon vapour as a menstruum than upon water in its common state: so that solution does not goon so well till its heated to the boiling point.

Ignition may be considered as a previous & auxiliary step to the action of the air as a menstruum & that by converting it into vapour which is the proper condition for the air to act advantageously on it as a solvent

In the distillation of the vitriolic acid, if no such air finds a passage into the vessel during the process the vitriolic acid thus obtained will be in a fixed state; but if air be admitted towards the end of the operation, it will then afford us a vitriolic acid in a volatile state, as was accidently discovered by Stahl. for during the distillation of vitriolic acid his apparatus happened to be cracked & let in the air. The effect of this being once observed, an apparatus was afterwards provided with a hole drilled in the Glass & stopped up with a peg so that it could be opened whenever the operation required in order to render the acid volatile.

We learn from hence that the action of the air concurs

as an agent as well to favor & promote exhalation as to procure a different exhalation from what would happen without its concurrence, & likewise that it assists in the resolution & decomposition of bodies by its affinity towards, or attraction of, some one or other of the principles of those bodies.

It is often necessary to limit the action of the fire, least by burning the substance it should affect it i.e. an Empyreuma as the thinner & more aqueous fluid first evaporates by heat in the inspissation & extraction of vegetable substances what remains behind becoming thicker & thicker is more liable to contract an empyreuma unless as it thickens we remove part of the burning fewel, or graduate the heat by suffering only a certain quantity of air to pass thro' the fire at a time or by the interposition of a substance that will prevent the heat rising above a certain determined degree, as in a water bath or sand heat &c.

It is to be observed that in volatilizing one part of a mixt we should not employ such a heat as to alter the nature or destroy the texture of the fixed parts that are to be left behind.

When a body is made up of parts, different degrees of heat successively are necessary to be made use of in order to obtain those parts separate from one another whether we

× Table of the diff.t deg.rs of heat w.h constitute the boiling point of diff.t liquors has been formed by some chemists

want to obtain the volatile & fixed parts.

When we speak of keeping up the heat of fluids to their boiling point it must be understood of homogeneous fluids. for in heterogeneous fluids the boiling point is continually varying, for as the more volatile parts fly off a greater heat is constantly necessary to keep the remaining fluid at its boiling point.×

Monsieur des Amantons in the memoirs of the royal academy of Sciences informs us that when water once comes to boil you cant afterwards make it grow hotter, this valuable discovery is however much improved by the very curious observation of the industrious Fahrenheit for he has found that the heat of the same boiling water will be constantly greater when the weight of the incumbent atmosphere presses heavier upon its surface & less when the pressure of that is lighter. In the mean time it is certain that so long as the atmosphere continues the same, boiling water will not grow hotter by any increase of fire whatever. In a lighter atmosphere the boiling point is lower, in a heavy & compressed atmosphere it will be above 212 of Fahrenheits thermometer.

Under the reciever of an Air pump place a glass vessel full of water heated to 96.° & gradually draw

out the air & you'll evidently perceive an ebullition excited in the water as the pressure of the atmosphere is lessened which will entirely disappear again upon letting in the air; hence therefore by a Barometer fixed in the Receiver you may be able to determine what degree of heat is necessary to make water boil under any given weight of the atmosphere, & by this means we may come at an infinite number of beautiful discoveries that we are at present unacquainted with x Boerh: v 1 p. 104, 105

There is one thing more on this head worth mentioning. If water be put into Papin's digester & the included air be stopt up with it in such a manner that nothing can possibly come out & it be made to boil; from the compression of the air on its surface the water will require 30 degrees of heat more before it boil; no wonder then that such prodigious effects are produced by this machine.

Evaporation is most readily performed in open vessels, when the liquor is exposed to the air by a large surface, especially if it is directed upon it in a stream continually renewed for this prevents a saturation of the air as a menstruum which takes place in close vessels.

* Calcination does not depend on the exhalation of the more volatile parts alone, for altho' we see fumes arising & dissipated during the process yet there is often an encrease of weight as in calcined Lead — this weight must be d[erived] either from the fire or air, the latter is obviated as we are told it happens in close vessels, therefore it must pro[ceed] from the fire, not the gross matter of fuel as we are told it happens by heat commun.d by the rays of the [sun] collect.d by a burning glass, hence it is a matter that accompanies light & fire & on this is founded Mr. Boyl[e's] Essay of the ponderability of light & fire.

So when we see bodies reduced by calcination to a powdery form, we are not always to impute it to a loss of the substance wh. the chemists call Phlogiston, for say they, by restoring this the calces of metals assume their metallic form.

For then we must say calcination is owing to the loss of phlogiston, & reduction is brot. about by restoring the lost phlogiston wh. coincides very badly with the observation of the above experiment.

Vegetable bodies burnt to ashes is called Incineration.

In practising of Exhalation it sometimes happens that by evaporating some of the more volatile parts that are cementitious the remainder is friable & falls down in powder; this is called Calcination* & differs from Exhalation in this, that in the latter case the body operated upon while retains its former figure (& texture) after having been exposed to the strongest action of the fire.

It is curious to observe that in roasting of crude Antimony to drive off its Sulphur it continues to exhale by heat so long as it does not fuse but no longer. If then by accident in roasting this ore a fusion should happen we must let it cool so as to assume a solid form, before we can proceed in driving off the remaining volatile part by exhalation.

When a substance is incorporated with another by means of fire, but without fusing either of them the method used for this purpose is in general called Cementation. Iron thus impregnated with an additional quantity of phlogiston is called Steel as by encompassing it with charcoal dust & then exposing it so encompass'd for a certain time to a degree

* Macquer vol 1 p 64

* Macquer vol 1 p. 343

of fire barely sufficient to make it red hot; or by fusing it with matters that contain phlogiston.*

Silver may be dissolved & separated from Gold by cementation with a mixture of fine brick dust four parts, vitriol calcin'd to redness one part & sea Salt or Nitre one part moistned with a little water into a cement, of w.ch alternate layers disposed in a crucible with plates of the metal to be operated upon & luted with a paste of windsor loam & water & thus placed in the furnace,* will eat the Silver from the Gold w.ch must be repeatedly boil'd in water till insipid.

That operation whereby bodies are resolved into their principles by the immediate application of fire is call'd Inflammation, thus the acid may be extracted from Sulphur as in obtaining the Ol: Sulph: per campanum; as both Geber and Glauber frequently operated in this manner the operation has sometimes been call'd Sublimatio Geberiana & at other times Sublimatio Glauberi.

Of Distillation

Having spoke of the operations for obtaining the fixed parts of bodies, we now come to those which are designed to obtain the volatile parts; but we must observe that tho' such division is useful, yet in most cases the operation is the same, & blended so as as many times not to be separated, as we obtain both; but we denominate it here according as the principal design is to obtain the volatile parts.

This is twofold, as the part separated rises in a fluid form, then it is called Distillation, or when in the form of powder or flowers then call'd Sublimation. But the rules & remarks that apply to the first chiefly apply to the last also. and as we more frequently use the former we shall begin therewith.

Distillation is one of the principal operations of chymistry: it is simple when a single body is subjected to Dist: & then it is call'd Distillatio per se, or when any thing else is join'd therewith & then call'd Distillatio cum additis.

In the first the ancient chymists operating on a single body by distill.^{n} obtaind diff.^{t} parts successively as Sp.^{t}, oil, water &c: they imagin'd it to be an analysis of the substance & call'd it chemical analysis but as it produces changes on the structure is not a proper analysis.

* Here shd. be mentioned the effect of air in volatilizing nitre by letting it into stills as first observed by Stahl. vid Antea.

As to distillation in general we have little now to say having sufficiently explained the principles of this when on Exhalation in gen.l & Evaporation a species of exhalation. But what we have to add is, that distillation depends almost entirely on the power of fire alone, tis true there is space enough in our distilling vessels to allow air at first but this is soon rarified & escapes so that at the latter end the distill.n is carried on by fire alone.

This shews the effect of air in distill.n as it requires a much greater force of fire to distill in close vessels than in open ones, & especially if exhausted, as Mons.r Papin has shewed, & as occurs tow.d the end of every distill.n; the vessel being then nearly exhausted.

Besides the distill.n turns out differently, a different resol.n & production being brought about from the effect of air in promoting the exhalation & resolution of the bodies & combining w.h them & so produced.

We come now to distillatio cum addito.

The different cases of distill.n with addition are 7 (v: text book) the 3 first depend on elect: attract.n to separate bodies. 1st: to set loose a volat: part; for by setting loose vol: part from its cohesion it rises in distill.n, So nitre w.h is a neut.l salt comp.d of acid & alkali; if it be resolved so as to set loose the acid w.h is vol: it rises in fumes, this is done by an acid w.h having a stronger att.n to the alkaline basis of the nitre unites therewith & detaches the nitr.s acid which is agitated in rising by heat

The 2^d. case is whereby means of elect: attr^n, we fix one of two volat: parts. It may happen that two volat: parts being united become comparatively fixed such is comm^n. Sal Ammoniac compos'd of mur: acid & vol: alk: both parts when separate are volat: when united more fixed, but by an elect: attraction you may fix one part more & detach the other – the substances used are different according as you want the acid or alk: separate

The vol: alk: may be separated by means of fix'd alk w^{ch}. will detach it – the acid by means of either vitriol: or nitrous acid. The 3^d. case is where two fix'd bodies united there is a necessity to join a third with one of these to form a new mixt w^{ch}. will be volatile in toto. So crude antim^y: is compos'd of y^e metallic part & Sulphur w^{ch}. are both fixt when united, but the muriatic acid being united with the metallic part volatilizes it & brings it over by the assistance of heat in form of thick oil called Butter of Antimony.

These three cases may happen to be combined, for whilst we add muriatic acid to volatilize the metallic part we also add mercury in order to join & fix the Sulph: till the other is got over w^{ch}. makes the operation more complete.

The other 4 cases do not depend on elect^{ive} attraction.

The 4^{th} case is where a body join'd to the whole volatilizes the whole, So metals may be volatilized by various additions as

as the mur: acid or Sal ammon: by means of w.ch we can render Copper or Iron volatiles as to get them over in Distillation

The other three purposes may be brought under one head, the 7.th or last is incorrect in point of language, the other two by dividing an aggregate & so prevent its fusion or Intumescence facilitate resolution & separation.

So clay, entirely pure from vitriolic acid, by means of dividing nitre, favors the resolution of it into acid & alk: when heat is apply'd to volatilize the acid; but M.r Pott recommends three times the quantity of clay to one of nitre that no two particles may be conjoin'd

An air is separated which recovers its elastic state by the operation — I have mention'd two diff.t states of air as fixt & elastic, but probably air is in more states, as seems to be proved by the air extracted from bodies by exhausting receivers —

Sometimes the air breaks from the most viscid liquor w.h such violence as to endanger breaking the vessel; at other times when the liquor is less viscid it escapes gradually & then does no harm

This will give us an Idea of froath & intumescence, against which we are to guard, as they may carry over the liquor to the damage of the operation; hence Sand is added to amber in distillation & several other bodies. tho' some chemists say Sand is not necessary at least may be obviated by regulating the heat & close

attention to it, but as this requires a painful attention
to sand relieves you from the necessity much like the piger
henricus; sometimes the froath is so viscid & plentiful
as to carry up a great quantity of sand, but this being stir:
falls down & breaks the bubbles rendering the conduct of
the separation much easier, but you must take care
that your sand be used only in such cases, as such sand
is not to be ~~acted upon by the body~~

7th & lastly we make addition in order to regulate
the heat, thus when we want essential oils we break
their texture & by moderate heat the volatile ess: oil easily
separates; sometimes not requiring more than boiling heat
of water, but if we distill without addition we should
find it difficult ~~to prevent the heat~~ rising higher & this
last addition of heat gives them an empyreuma, hence
the necessity of water to keep plants afloat in the still
& w.h will not take heat above a boiling point so that
they are in no danger of empyreuma. So are the directions
of the dispensatory in these cases are to add water sufficient
to prevent empyreuma w.h certainly is prior to the regulation of heat

All these things being mentioned in every distillation
it is necessary for a person to consider

Exhalation &c.
consider the use of every article & what purpose they serve if you would be intelligent or understand the subject.

Rectification, Dephlegmation Concentration & Cohobation

when the purpose of a 2d. distillation is only in order to separate some parts that adhered in the first distillation the 3 first terms are apply'd

The adhesion in the first case may be owing to both parts being nearly equally volatile so that both comes over together, but by the 2d. distillation, more care being used, you separate them; this therefore is properly eno' called Rectification & takes place in procuring alcohol from fermented liquors, wh. cant be got pure in the first, on acct. of the adhesion of some bodies of near the same volatility; but separate in the second; this however is sometimes not sufficient to make the separation perfect but requires 3, 4 or 5 repeated operations.

Phlegm is a term apply'd to water, so when water is separated whether by distillation or otherwise then it is called Dephlegmation so we say well dephlegmated Alcohol ~~—~~ Dephlegmated Acids &c.

When it happens that the water is the most volatile part as in acids & wh. it being separated

from the other, brings the parts of the body nearer together
hence the term of Concentration w^ch is different from
condensation as that is bringing parts nearer together
by means of cold &c: without any separation of parts.
but this applys parts brought nearer together by means
of withdrawing other parts—

when in case 3^d. & 4^th we separate only one part
of the mixt from the other by volatilizing it, we add
a volat: body in order to volatilize the whole but the
vol: body comes over without volatilizing the whole & we
restore it again to render the volatilization of the whole
more perfect this is called Cohobation.

So sal ammoniac apply^d to Iron or Copper
takes up a certain proportion only, but by returning this
w^ch comes over on what remains & repeating it a second time
you get a greater portion of the Iron or Copper or the
whole of it is rendered volatile

Sometimes we apply water to plants to be impreg:
nated with their taste or other the impregnation the first
time is often inconsiderable because the vegetable affords
but little, then we return the matter distilled on a fresh
parcel of the same to get a stronger impregnation

which is the second case of cohobation. in the other the matter distilled was returned again on the former matter —

Distillation with regard to the form of the vessels employ'd is of three kinds viz. per ascensum, per latus & per descensum

In the first case we make us of an alembic or Cucurbit. The alembic or common Still is generally made with Copper lined with Tin, it consists of two pieces the lower called the body of the Still & the upper the head; when made of Glass the body is called a Cucurbit

In the 2d. operation we employ as more convenient a Retort & reciever & from this course of the vapor the operation is called distillatio per obliquum vel per latus.

These are the only ones now in use.

The 3d. is as ancient as either of the former in which the vapors are driven downwards from the matter from which they come. The method was to take a Cucurbit with the mouth ~~upwards~~ on wh. was placed the matter to be operated upon, on this an Iron plate over wh. fire the heat of which drove out a vapor from the body wh. formed into

drops into the Cucurbit under it, this operation only described in old authors now out of use.

As to the vessels employ'd in distillation regard is to be paid both to the _matter_ & _form_ of them

matter. I have shewn why glass is preferable to every other matter where the heat of the fire is not too great, for here we must employ _earthen_ vessels & glass vessels put nearly into the same situation

Flint or crystal glass vessels are easier fused than brown bottle glass, w.ch sustains a great heat of fire tho' we use the advantage of transparency for a more important one of its rendering stronger the action of the fire. It sometimes happens that we want a degree of heat w.ch act even on this brown glass, but as it does not fuse readily so as to run, by means of a crust of earth spread over it of the same materials as our melting vessels its form is preserved, & the heat is equably apply'd, this is called a _coated_ retort

But when the heat is so great that this is not capable of sustaining it, therefore are vessels of a particular earth of w.ch we shall speak hereafter.

where we want vessels so large that no glass vessel can be made sufficiently large for it we are obliged to use a metallic one such as the coppers of brewers &c:

when an operation does not admit of very great heat metallic vessels may be employd provided the matter operated upon is not subject to corrode them as in operating on watery fluids &c — If we use Copper vessels we should take care to keep them clean & dry —

Form. That is determined by various considerations chiefly the volatility of the matters to be distilled. If we are to separate from each other two fluids of nearly equal volatility, as the same heat nearly volatilizes both, we must make use of a vessel drawn out to such a height that the more volat. will ascend to the top, the less volatile not; on this foundation sometimes a preference of the Cucurbit over the retort has been given — but I believe it seldom happens that glass vessels can be made of such length as entirely to answer this purpose, therefore we gen^l. use a metallic vessel

In rectifying ~~ardent~~ ardent Spirits in a common Still the water is so nearly as volatile as the spirit that it is apt to come over with it. Boerhaave imagined that if from the top of an Alembic a pipe of several feet high was employ'd it w^d. effectually prevent it, but I dont find so much advantage in the height as in the graduation of heat of w^h. hereafter.

Nor unless it were great, are we to use the matrass in preference to the retort because as the vessel must be an

limbi &then abolt so 2 junctures to be closed makes
it inconvenient — hence we now more universally use the
retort & reciever, as the orifices may be better fitted to one
another & the junctures easier closed. Cucurbits are now seldom
made at Glass houses being much out of use

There is only one case where the cucurbit is preferable
viz. where in the distillation we are to begin with a small
heat & continue to the greatest violence wh. a glass vessel
will sustain in a naked fire.

where this is necessary the chemists generally begin
their operation in a retort & sand heat, afterwards remove
the matter to a coated retort, this cannot well be done
without heating the retort so a matrass or Cucurbit is preferable as
the matter can be more easily got out of them.

In the practice of distillation there are several
particulars necessary to be considered.

1st. The manner of putting the matter into the retort.
This must be in the bottom none in the neck or it will
undo or into the reciever to the detriment of the operation.
when we put in fluids we use a long neck'd crooked ~~[illegible]~~
funnel reaching nearly to the bottom & withdraw it with
caution so as not to let a drop touch the neck; when we
put in dry powder it must at least be wiped out clear
with a feather.
whenever there are operations wh. require additions during

the operation we should have a tubulated retort with a stopper ground to fit it, which will suffer you to put them in as you please & stop them up closely. Other cases requiring a tubulated retort are where from putting in the matters, fumes are generated in every great degree, then it is necessary, first to put the retort in its place & lute on the receiver very well, & then apply the matter by the tubulated retort so that the fumes may pass into the receiver.

Are we to put in the matter all at once? or how far may we fill the retort?

When there is intumescence we must leave space in the neck to give room for the fumes. A common direction is to fill the retort 2/3 full, but that cant be often unless in a long bodyed or english retort, in some cases it must not be filled above 1/3 full, & in cases where there is no intumescence we may fill it nearly to the neck; besides, when the vapors rise suddenly & very elastic we must leave as much room as in intumescence

2dly Fitting the receiver to the retort. The retort must have a neck so long that the condensed vapor will fall from the nose into the body of the receiver without touching the neck wh. might thereby be easily broke, this

is an universal rule.

The neck of the retort must have such an inclination that the vapors condensing in it may not return into the body of the retort again but fall into the reciever.

The last way of fitting the neck of one to the other is, when made nearly of a size to put in a little emery & to grind them to fit each other by working round a little, but as we dont always want such close juncture we may just put them together & lute them in the common methods —

3.dly Of luting the juncture. An ox bladder mentioned, cut into strips an inch broad & long enough to go round 2 or 3 times & then tyed with twine will do when the vapors tho' penetrating are not very elastic or corrosive in w.ch case the bladder wont do.

There we close the junctures with paste as common paste if the vapors are mild, or with the paste we use a little whiting or chalk to make the juncture firm; but a bladder is better than paste where it is sufficient, as it does not foul the neck of the ~~retort~~ reciever.

Where the common paste is not firm enough one made of the flower of linseed may answer but that is

not sufficient when the vapors are corrosive, then a paste is used whose basis is a clay, hence the name of luting, but simple clay is not sufficient, for with the best earth or pipe clay it is necessary to mix a portion of sand or of burnt clay coarsely powdered to the size of sand so as to take off the tenacity & give it the power of concreting without without cracking or flaws. The matter must be put round the junctures of some thickness & then a moist bladder over it & tyed up, but if we aim at a tight close luting, we must apply the fire by slow degrees or dry the luting in some measure first, & when cracks & flaws happen to fill up with more lute before we put on the bladder. But the junctures must seldom or never be absolutely close

When properly luted the retort is to be committed to sand in an Iron pot having sand in the bottom to give it a steady motion & preventing its touching the bottom, then we are to fill it up with sand almost to the top for reasons hereafter to be mentioned.

4.thly Applying heat. The fire should be moderate at first, equally applyd & gradually increased, otherwise the vessel infallibly breaks, besides there is another purpose

of the gradual application of the fire in order to separate bodies according to their different degrees of volatility. Bodies often approach near to each other in volatility so that great accuracy must be used to apply such a heat as will exhale the most volat. part & not the other. Patience therefore is necessary & haste always defeats the operation.

If we urge the heat too fast there is danger of bursting the vessel about our ears by forcing up smoke vapors than the vessels can contain & condense at once; hence the necessity of caution in the conduct of the fire for that purpose. Otherwise the vapors will rise faster than can be condensed; this rule is universal.

It is true there are some very few instances w. ch are exceptions to the general rule, where we must get the vapor raised as soon as possible; this very rare & requires a knowledge of the particular subjects.

5. by Preventing the vessels being burst by the quantity or elasticity of the vapors. For this purpose the fire must be raised slow & the vessel be large enough to contain the matter when swelled, but in many cases where the vapors are very elastic, we are not to depend on the cautious management of the fire or largeness of the vessel alone, but it is necessary to

allow some issue to the vapors so as to render the operation safe without spoiling the process by waste. for w.ch purpose some use a loose luting to suffer the vapors to escape thro' it, but this is awkward & not easily determined, besides there is more danger of the escaping fumes catching fire & thus endangering the operator — Others therefore propose a vent in the reciever. by a vent tube of great height in which the pressure of the air will prevent the vapor from escaping too much, & yet to give issue to very elastic vapors, but the objections against it are that a long tube is apt to snap from the least inclination & seldom employ'd on that acc.t, & as it cant easily be fitted to the tubulated reciever, altho' Dr. Lewis is very fond of it.

Another contrivance is to drill a small hole in the upper part of the reciever & put a peg loosely in it or a slight stopper of luten, either of w.ch will be thrown out before the vessel would burst; besides, when we see the elastic vapors arising in great quantities & so filling the reciever as to require vent, which is easily known by one used to operate, the peg may be pulled out so as to let some escape. This is the contrivance most useful & much employ'd. By this Mr. Godfrey was the only person capable of making Phosphorus & sold this secret to the King of France for a great Sum — in every

× Large globular recievers are sometimes
used for this purpose called Ballons

other manner the vessels were burst

There is an advantage in the size of the reciever to condense the vapor, & [illegible] having the ~~retort~~ long necked to remove the reciever farther from the heat. There are means of answering ~~both~~ these methods by what are called adopters, intervening between the retort and reciever, being hollow spheres as it were, like beads threaded on one another*. Other means may be used by wet cloths constantly renewed & apply'd round the reciever — Sometimes the reciever is supported & kept steady in water so as to condense the vapors.

~~6~~.ly Preventing the matter from concreting in the neck of the retort so as to choak it up. This happens often in sublimation where the vapors condense before they are pushed into the reciever which if urged on will burst the vessel. When the matter is dry we have no other resource than stopping the operation w.ch might have been prevented by keeping the neck warm from the begining with warm flannel wrappers or sand heaped up round it.

But when the vapor concretes into an unctuous fluid as butter of antimony, we must apply hot coals round the neck of the retort to melt it down &

make it flow into the receiver.
So in distillation of expressed oils, it is often necessary that the warm water be suffered to remain round the worm & not renewed (as necessary in many cases) so as to keep all warm & fluid
Throwing air into the distilling vessel during the process expedites the operation, especially where air acts as a menstruum, as in distilling the oil of vitriol, by letting in the air during the operation renders the acid volatile & brings it over easily; this was a chance discovery of Dr. Stahl's, but Mr. Hales's essay of throwing in air is of most importance & is to be consulted on this occasion.
7:ly Separating the matters that are brot. over.
In general we find means to make the separation after all is come over, but it is often necessary to separate them successively as they come over, the common method is by changing the receiver, but then we must employ adopters otherwise if the receiver is removed the cold air rushes in & breaks the vessels; but there is a difficulty attends the use of adopters from the firmness of the lutes which afterwards difficultly dries.
A better practice is to have a spout receiver that is, a tube at the bottom of the receiver to be turned

into a bottle slightly luted so that the little cold air thus admitted has less danger of breaking the vessel.

It is necessary to let the vessels cool before opening them, otherwise they may break. Further the vapor is not condensed frequently for some time, & if opened too soon before condensation this would escape & be lost.

Another consideration is, that some of the vapors are permanently elastic & of a deleterious quality, which the operator should avoid taking in by inspiration, as they might speedily suffocate him. To this add that the luting must be carefully removed before you pour off the liquor, least it should thereby be dissolved to the detriment of the fluid.

Oil & water may be separated from each other by means of evaporating ~~mug~~ a funnel which is best learnt by a little practice.

Oil Salt &c. are separated by a second distillation as in obtaining oil & Salt of Hartshorn &c.

8.ly The last rule for the conduct of distillation is, that the operator should attend to the nature of the vapors escaping from the vessels during the course of the operation; if inflammable no fire or flame should be brought near to it, lest the steam be com=

communicated to the substance within, & occasion the loss of it & explosion of the vessels.

By attending to these general rules in reading of authors you will understand the nature & management of each process not so fully explain'd elsewhere.

Of Sublimation

Sublimation is conducted on the same principles as distillation & most of the same rules take place here. All the difference arises from the disposition of the body to concrete into a powder or flowers to which many have such a disposition that we may often practice on them in an open vessel

The diversities of the apparatus for Sublimation cant be treated of here, as they arise from the particular nature of the body to wh.ch they are to be referred.

Sulphur is a body which, exposed to sublimation, gives a dry powder called Flowers; when we practice on Quicksilver with the muriatic acid what comes over is in a solid form, which more strictly is called a Sublimate.

If in the writings of chemists you find any opera-
tions which I have not mentioned, you will readily
understand them & be able to refer them to the
proper one of the three heads I have marked out.

This finishes our subject of the operations
of chemistry ———

Part 3.d
Of the chemical history of bodies.

A chemical history of bodies otherwise term'd an account of the chemical qualities of bodies makes a very principal part in the study of chemistry; it is conversant in explaining the causes on which the chemical properties of bodies depend & the manner of inducing or destroying them.

Chemical qualities are the particular properties of bodies, or such as cannot be referred to the properties of bodies in general

It is but of late that chemistry has been considered & treated of in a scientific or methodic manner, for a long time the chemists had entertaind a too contracted notion of their own art; they first confin'd it to the doctrine of metals, & afterwards limited it to pharmacy; but at present chemistry is much improved by extending our views to a general and

comprehensive knowledge of the particular properties of bodies.

It has been a faulty custom of the chemists to class the different subjects of chemistry under the three heads of the animal, vegetable & fossil kingdoms; but how improper & confused a method this is appears very evident even in one particular, that is, in treating of the doctrine of salts some of which are obtain'd from the fossil kingdom, others from the vegetable & some from the animal &c: how much better is the manner of distributing the objects of chemistry (in the manner we have already mentioned) into saline, inflammable, metallic, earthy & watery, to which may be added aereal.

Fourcroy makes 3 Genera of simple Salts

Genera	Species
Earthy	Terra ponderosa Magnesia Quicklime
Alkaline	Vegetable fixed Alkali mineral fixed Alkali volatile Alkali
Acid	Acid of Chalk. aerial Acid marine Acid sparry Acid Nitrous acid Aqua Regia Vitriolic Acid Acid of Borax

Of Saline substances

Salts we have said are divided into simple and compound.

The simple salts are acid and alkali which terms are generical containing each of them several different species: thus of acids there are generally reckoned 4 species and of alkalies three — these include all the simple salts we have yet any knowledge of.

The four species of acids are the vitriolic, nitrous, muriatic and vegetable.

The alkalies are two of them fixed viz.t vegetable & fossil, named after the subjects from which they are taken, and the third volatile.

Some chemists have advanced it as their opinion that there is but one acid in nature, strictly speaking, of which the four above enumerated are only varieties. Others assert that there are several kinds of acids besides them of different nature & properties, as acid of amber, of phosphorus, of borax, of ants &c: but

leaving this subject as we find it, 'tis sufficient for our purpose to consider those four acids we have mentioned as differing in their powers and properties — To avoid ambiguity we shall call them by their different names, & consider them as so many different extraordinary productions of nature examining their properties very attentively as being most universally known.

Acids and alkalies mutually attract & unite with each other forming combinations which give us so many different Salts as they form new combinations.

Only one acid & one alkali can unite together at once, so as to form a Salt; therefore multiplying the 4 acids with the 3 alkalies we have the number of compound salts which can possibly be formed from them in number 12 — they are termed neutral.

Pomeroy makes 6 Genera of Compound Salts composed of an Acid united with fixed Alkalis, volatile Alkali; Lime, Magnesia, Clay & Terra ponderosa. He does not reckon the union of Acids with the metals amongst saline substances.

It is the property of salts thus combined to have their natures wholly changed from that of the acid or alkali which composes them — they have a set of qualities different from either nor do they partake of a middle state between both; on this account they are called neutral.

These neutral Salts composed of an acid & an alkali are called perfect salts as well as the simple salts; but besides them there are no other perfect compound salts.

The compound Salts are of three kinds neutral, metallic, and earthy.

A neutral salt is composed of an acid and an alkali & (as we said before) is a perfect compound Salt.

A metallic salt is composed of an acid and a metal.

An earthy salt is made up of an acid combined with an earth. These two last are imperfect comp.d Salts. — All compound salts have an acid for one of their ingredients.

As an acid will combine with only one alkali at a time; no more will it combine with more than one metal or one earth at once.

alkalies, metals, & earths have a greater tendency to unite with one acid than another; & the acids have a stronger attraction with, or affinity to one alkali, one metal, or one particular earth than another; & as it cant combine with more than one at a time will leave that with which it has the least attraction to unite with that to which it has a greater affinity provided they be put in proper circumstances, the principal of which is solution or fusion and being placed in contact.

The acid will unite with these different substances so as to make compound Salts only in certain proportions, different in different acids & the various particulars with which they are united whether alkali metal or earth.

Hence it is that the number of compound Salts are limited to four times the number of Ingredients which will unite with the 4 acids, & the number of

neutral salts are consequently 12 whereas could they form salts in different proportions we should have a greater variety of neutral salts & of other compound salts according to the different proportions in which they can be united.

In the following table are set down all the neutral Salts, and are placed after one another in order according to the different force of attraction between the acid & Alkali — all the alkalies have a stronger attraction to the vitriolic than to the nitrous acid & to this than to the muriatic; their attraction with or affinity to, the vegetable acid being the weakest of all

	Vitriolic Acid	Nitrous acid	Muriatic acid	Vegetable Acid		Sal Sedativ
				Acetum	Tartar	
Fossil Alkali	Sal Glauberi	Cubic Nitre	Sal Commun		Sal Rupell:	Borax
Vegetable Alkali	Tartar vitriol	Nitre	Sal Digestiv:	Tartar Regen:	Tart: Solub:	
Volatile Alkali	Vitriolic Ammon:	Nitrous Ammon:	Sal Ammon:	Spirit mind:		

Acids	Alkalies	Neutrals
Vitriolic.....	vegetable	Tart: vitriolat
	fossile	Sal Glauberi
	volatile	Vitriolic Ammon:
Nitrous......	vegetable	Nitre
	fossile	Cubic Nitre
	volatile	Nitros Ammoniac
Muriatic...	vegetable	Sal Digestivus
	fossile	Sea Salt
	volatile	Common Ammon:
Vegetable....	vegetable	Tart: Regenerat:
	fossile	Sal Rignette
	volatile	Spt: Mindereri

A Table of Compound Earthy Salts.

Vitriolic acid . . .	absorbent argillaceous calcarious	Earths	magnesia Glaubers Salt Alum Selenites
Nitrous Acid . .	absorbent argillaceous calcarious	Earths	wont crystalize Aluminous Salt fixed Nitre
Muriatic Acid . . .	absorbent argillaceous calcarious	Earths	wont crystalize aluminous Salt Sal Ammoniac: fixum
Vegetable Acid . .	absorbent argillaceous callcarious	Earths	wont crystalize . . . . . d°. . . . . . . d°.

Metallic Substances	Vitriolic Acid	nitrous Acid	muriatic Acid	vegetable Acid
Gold	wont dissolve	wont dissolve	wont dissolve	wont dissolve
Silver	requires heat	Lunar Crystals	only corrodes	wont dissolve
Copper	blue Vitriol	greenish liquor	dissolves ...	Verdigrease
Iron	green Vitriol	reddish liquor	dissolves ...	rusty Salt
Tin	only corrodes	only corrodes	dissolves w^th. difficulty	scarce corrodes
Lead	only corrodes	saccharine Crystals	only corrodes	Saccharum Saturni
Mercury	Turpeth mineral	wont crystalize	Corros: sublimate	scarce corrodes
Antimony	requires heat	only corrodes	only corrodes	Emetic part
Cobalt	only corrodes	wont crystalize		
Bismuth	wont dissolve	wont crystalize		
Zinc	white Vitriol			
Arsenic				
Platina	wont dissolve	wont dissolve	wont dissolve	wont dissolve
Nickel				

Having spoken of saline substances in general we next proceed to speak of each one in particular, beginning with the simple salts.

Of the Vitriolic Acid

1st Its Natural History. The vitriolic acid is a native substance supposed no where to exist in a separate state because of its great affinity with various bodies. It is found combined with different substances.

1st Salts. As to Salts it is only found combined naturally with the fossile fixed alkali forming Glauber's Salt.

2d Metals. It is naturally found combined with Iron, Copper, & Zinc, forming green blue & white vitriol.

3d Earths. Its found united with absorbent Earths as magnesia, forming magnesia Glauber's Salt, with the absorbent part of clay forming Alum, & with calcarious earth forming Gypsum or Selenites.

4th Infeammables. It is found united with the Phlogiston forming Sulphur, & in the pyrites & oars of metals.

5th Water. Its found in water only in consequence of neutral metallic or earthy Salts being dissolved therein, & in the same manner

Mr. Lavoisier has demonstrated
1 That Sulphur cannot burn without the help of Air
2 That during combustion it absorbs the purest part of that fluid.
3 That the residuum of Air cannot serve for a new combustion
4 That the vitriolic Acid which results exceeds the weight of the quantity of Sulphur which produced it by the exact weight of the Air lost during combustion
5 That in consequence the Sulphur is combined with the portion of pure Air which is absorbed in order to form the vitriolic Acid. This Acid is therefore a compound of pure Air & Sulphur
6 That Sulphur in place of being a compound body is only one of the principles of the vitriolic Acid & requires no more than an union with pure atmospheric Air to form this Acid, which is done by combustion

in the Air. It remains a doubt whether the vitriolic acid is ever in a natural state in animal or vegetable substances. It is in all electric matter for the snap or shock is a decomposition of it as is evident from its changing the colour of Roses in the same manner as that Acid.

2^d. Its chemical preparations or methods of obtaining it. The vitriolic acid is extracted from vitriol, sulphur, & the Pyrites, but most frequently from vitriol whence its name is derived. The process for obtaining it may be seen in Macquer. This acid may be rendered volatile several ways, 1^st by allowing air to pass into the retort during the process for obtaining it from any fixed body. 2^d. by being united with Zinc & distilled therefrom it will arise in a volatile estate. 3^d. by uniting it with inflammable substances as oil or Alcohol & elevating it therefrom by distillation, or from Sulphur by burning it & placing cloths over the same previously wet in a solution of any fixed alkali with which the acid unites forming a vitriolated Tartar, & from which it may be extricated by the fixed vitriolic acid. 4^th It is in a volatile state in Hepar Sulphuris & may be obtained therefrom by adding a fixed vitriolic acid thereto.

3.^d Its separate properties. The vitriolic acid is the most ponderous of all fluids except Quicksilver & some metallic solutions. Farenheit determines its specific gravity to be to that of water as 18,775 to 10,000. In its fixed state it is considerably more fixed than any of the other acids, emitting no fumes or smell in the greatest heat of the atmosphere or even in that of boiling water. Exposed to the air it imbibes humidity. It is the most powerful of all acids though there are many substances which it does not act upon so violently, or dissolve so readily as some of the others do; it checks fermentation & putrefaction.

4^th. Its relations to other bodies. 1.^st Saline. It unites with the other acids generating heat. It has a greater affinity than any of the other acids with alkalies uniting therewith with heat & effervescence forming a tertium quid; if the alkali be in a caustic state no effervescence happens. 2.^o Metals. The vitriolic acid will unite with all metals; with some it has a greater affinity & with others a less than the other acids, particularly the muriatic which will disunite it from Silver & mercury. It dissolves Iron & Zinc, but requires to be first diluted. For Copper it must be concentrated & for other metals it must be

in its most concentrated State & assisted by heat. Gold is scarcely acted upon by it. 3.° Inflammables. the vitriolic acid discovers in general a stronger attraction to the inflammable principle than any other known Species of matter & when com=:bined therewith forms Sulphur. There are circumstances however in which it forsakes that principle to unite with some metallic bodies, particularly Iron & Copper. If either of these metals be combined with Sulphur & the compound gently roasted or calcined, only the inflammable part of the Sulphur will be dissipated, its acid being retained by the metal which is thus corroded into a saline concrete. The same change is produceable without the application of any external heat from a bare mixture of Iron filings and Sulphur moistened with water. The vitriolic acid added to oils produces heat effervescence & blackness. With ardent Spirits it produces heat & effervescence, exhales a grateful odour & forms Æther. 4.th <u>Earths</u>. The vitriolic acid has the greatest affinity of any of the acids with absorbent earths & unites therewith with effer=:vescence, forming with Magnesia, Magnesia Glauber's Salt commonly called Epsom Salt.

with the absorbent part of clay forming Alum; & with calcarious earth into Selenitic concretes. 5th Water. If equal parts by weight of Oil of vitriol & water are hastily mingled together the mixture becomes instantly so hot as to render the vessel insupportable to the hand. 5 parts of the vitriolic acid are sufficient of saturate 8 or more of fixed alkali & an ounce of this acid when concentrated contains about 5 drams of acid & 3 drams of water.

5th Its various Names. In a concentrated State the ancients called it from its apparent lubricity the oil of Vitriol & in a weaker state the spirit of vitriol now generally distinguished by the names of Spiritus vitrioli fortius & tenuis. When obtained from Sulphur by burning under a bell shaped condensor Spiritus Sulphuris per Campanum; when obtained from Alum spirit of Alum &c. Some Chemists suppose the vitriolic acid is the basis of all the other acids both mineral & vegetable, whence they call it the universal, primogeneal, vague acid.

Of the Nitrous Acid

1.st Its natural History. The nitrous Acid is the most limited & least frequent in the Earth of all the mineral Acids. It is never found pure, & is seldom met with in any combination but in the neutral Salt from which it recieves its name. Some suppose it is the vitriolic Acid altered by putrefaction & the commixture of some inflammable matter. In proof of this Opinion an Experiment is alleged in which the nitrous acid returns back into the vitriolic; if two Ounces of good spirit of Nitre be digested with half an Ounce of Oil of Turpentine a balsam of Sulphur is produced possessing all the properties of Common balsam of Sulphur.

For the production of Nitre there is neces=sary 1.st a putrid or putrescible matter either from the animal or vegetable kingdom. 2d Certain earths as Boles, Clays, the plaster of old walls &c & 3.d Air. The Earth seems necessary as a matrix to generate the nitrous acid by means of putrefaction induced by the putrescible matter, & the Air is necessary to carry on the putrefac=tion. The vegetable fixed Alkali in Nitre is an artificial production.

2^{d} Method of obtaining it. The nitrous Acid is obtained in a separate state from nitre, only in consequence of its being decomposed from its alkaline basis by means of a stronger acid viz.^{t} the vitriolic. This is done either by adding the concentrated vitriolic Acid to a solution of Nitre in water, or by adding any substance having the vitriolic Acid in it & with which it has a less affinity than with the alkaline basis of the Nitre; for the vitriolic acid uniting therewith sets the nitrous Acid free, which may then be elevated by distillation. Green Vitriol is generally used for this purpose; for the process see <u>Macquer</u> vol 1 p: 252 or <u>Neumann</u>.

3^{d} Its separate properties. The concentrated nitrous Acid is weaker & much more volatile than the vitriolic. It is in part dissipated by the action of the Air in pungent vapors which appear before their diffusion of a red colour. In Distillation it rises in fumes of the same colour. If an unstopt bottle of it be set by one containing the volatile alkali, the vapors of the two will unite together & form a white cloud in the Air. It is of a light yellow color. Its specific gravity

is to that of water as 15 to 10.

One ounce of concentrated nitrous Acid will saturate seven drams of fixed alkali & contain two drams & a half of pure acid & five drams & a half of water.

4th Considered in its relation to other bodies.

1st Saline. It unites with the other acids generating heat, & has the greatest affinity of any acid except the vitriolic with alkalies with which it unites forming neutral Salts.

2d Inflammables. Combined with Oils it produces heat, a violent effervescence & blackness. If equal parts of a well concentrated nitrous Acid & essential oil be suddenly mixed together a violent heat & effervescence will ensue with copious pungent fumes & the matter will be turned to a charr; if a little more acid be then added it bursts into flame. Expressed oils may likewise be made to flame by adding thereto equal parts of the vitriolic & nitrous acids combined. If ardent spirits be poured hastily on the nitrous acid a violent heat & effervescence arises & the whole is dissipated in fumes into the Air; but if the Acid, e contra, be poured by little at a time on the spirits they will unite without any effervescence, but exhale a pungent odor & produce Æther.

3.° Metallic. The nitrous Acid won't touch Gold but either dissolves or corrodes all other metallic bodies.

4.th Earths. The nitrous Acid unites with Earths forming earthy salts that will not crystallize.

5.th Water. It unites with water generating heat, but with Ice it produces cold.

Silver dissolved in the nitrous Acid stains hair, bones, & other solid parts of animals and different kinds of Wood of all the intermediate shades from a light brown to a deep & lasting black; the liquor commonly sold for staining the hair brown or black is no other than solutions of Silver in Aqua Fortis so far diluted with water as not sensibly to corrode the hair. This solution inspissated to dryness is the Lunar Caustic.

5.th Its various Names. They are Spiritus Nitri, the nitrous Acid, Glauber's Spirit of Nitre, Aqua Fortis, Spiritus Nitri fumans.

The Muriatic Acid

1.st Its natural History. The muriatic acid is so called from Muria or Sea Salt from which it is obtained. It has generally been called the marine Acid because, as before said, it is obtained from the marine or Sea Salt; but as this salt exists naturally in the Earth as well as in the Sea & it remaining a doubt whether the Salt in the Sea does not owe its origin to this fossil Salt, & the term Muria including both, it therefore is most properly called the muriatic Acid. It is supposed by some chemists to be the vitriolic acid combined with an inflammable and a mercurial or arsenical principle. This acid may likewise be obtained from common Ammoniac, Urine &c:

2.d Method of obtaining it. This Acid is obtained from Sea Salt by being decom=:pounded from the alkaline basis thereof by means of a stronger acid as the vitriolic or nitrous, & then elevated by distillation. — For the methods of obtaining it both by means of the vitriolic & nitrous Acids see Macquer vol: 1 p 279. 286.

3.ᵈ Its separate properties. The muriatic acid is stronger than any of those of the vegetable or animal kingdom, but weaker than the vitriolic or nitrous. It is of a golden colour, & in its most concentrated state contains about seven drams of water to one of acid. It is in part dissipated by the action of the Air in pungent white vapors. It arises in distillation also in white fumes which condense on the sides of the recipient, in striæ like Spirits of wine. Its specific gravity is to that of Water as 12 to 10. It is the corrosion commonly used for anatomical purposes.

4.ᵗʰ Its affinities with other bodies.

1.ˢᵗ Saline. It unites with other acids generating heat. It unites likewise with alkalies with heat & effervescence, though its affinity therewith is less than either the nitrous or vitriolic Acids.

2.ᵈ Inflammables. Combined with oils it produces heat & blackness. It may be made to unite with Ardent Spirits but it wont produce Æther.

3.ᵈ Metallic. It easily dissolves Zinc, Iron & Copper. It will likewise dissolve Tin though with difficulty, & may be made to unite with most other metals but not in

a liquid state. It has a greater attraction to Silver, Mercury & Leads than any other acid. Aqua Regia is composed of the muriatic acid & nitrous acid, & may be made by digesting the two acids together. This compound is the only menstruum for Gold & is the true solvent of Tin & Regulus of Antimony, as the nitrous acid separate is of Silver.

4.th Earths. with absorbent Earths it forms a liquor that will not crystallize. — with calcarious earths it forms a neutral Salt called fixed Sal Ammoniacum.

5.th Water. The muriatic acid unites with water generating heat, but with Ice it produces cold though in a less degree than the nitrous acid.

6.th Its various Names. They are Spiritus Salis, Glauber's Spiritus Salis, the marine Acid, the muriatic Acid &c.

The Vegetable Acid

1.st Its natural History. This acid is only found in the vegetable Kingdom, & is by some supposed to be the vitriolic Acid absorbed & changed by the vegetable oeconomy.

Vegetable Acids are of three kinds native distilled and fermented.

The native vegetable acid is obtained by Expression from Limes, Oranges, Sorrel &c:

The distilled vegetable acid is obtained by Distillation from certain Woods as Pine Guaiacum &c: The acid of pine distilled from Tar or dry pine dropt into water makes a very elegant Tar water free from the filth & Empyreuma of Tar water made in the common way.

The fermented vegetable acid is the product of the acetous fermentation; during which process Wines, besides growing acid deposit a certain acid salt called Tartar which being purified is called Cream or Crystals of Tartar. This acid is different from Vinegar; hence fermented vegetable acids are reckoned of two kinds viz: Acetous & Tartareous.

The acetous acid combined with vegetable fixed alkali forms a neutral salt soluble both in water & spirit of Wine, & with the fossil fixed alkali a salt nearly similar.

The tartareous Acid is found to be different from the acetous. Its neutral Salt with alkalies is not soluble in Spirit of Wine.

2.d Chemical preparations. The native & distilled vegetable acids are prepared by the common methods of expression & distillation for which see Macquer vol 2.

The fermented vegetable Acid is obtained by a natural process which however may be assisted by art. Vinegar is best concentrated by means of Congelation or exposing it to the frost. For the depuration of Tartar vide Macquar vol 2 p: 274.

3.d Separate properties. The vegetable acid is much weaker than any of the mineral acids. Its specific gravity is little different from water. Mr. Homberg says an ounce of best Vinegar contains 18 grains of pure Acid. The tartareous Acid has the singular property of crystalizing, which Macquer thinks is owing to the small quantity of Oil & Earth which it contains.

4th Considered in relation to other bodies.—

1st Saline. Vegetable Acids will unite with the mineral acids, & with alkalies forming neutral salts.

2d Inflammable. they have no affinity with inflammable substances.

3d Metallic. The vegetable acid dissolves Zinc, Iron, Copper, & Lead, & extracts the Emetic quality from Antimony. The steams of vinegar corrodes Lead into a white powder called Ceruss.

4th Earths. The vegetable acid combines with the absorbent earth & forms a bitterish liquor

5th Water. It unites with water but does not produce any sensible degree of heat.

5th Various Names. The native vegetable Acids are commonly called the juice of the substance as of Limes, Lemons, Oranges, Sorrel, &c:

The distilled vegetable acid is seldom obtained in a separate state.

The fermented vegetable acid is called Vinegar, Distilled Vinegar, Tartar, Cream of Tartar, Crystals of Tartar &c.

To the foregoing Acids we may add sundry anomalous ones as Acid of Amber, Borax, Phosphorus, Ants, Bees &c. V: Mag: & Neuman.

Of Alkalies

Alkaline Salts are distinguished from all saline substances not alkaline by their effervescing with acids, forming with them neutral salts, precipitating solutions made in acids, and changing the Syrup of Violets green.

Alkalies are either fixed or volatile. Fixed alkalies are distinguished from the volatile by their fixity, fusibility & changing a solution of mercury sublimate of an Orange yellow, whereas the volatile Alkali exhales a very pungent order & sensible fumes & is not fusible by reason of its great volatility & throws down a white precipitate from a solution of mercury sublimate.

Fixed Alkalies are of two kinds vegetable and fossil. The vegetable fixed alkaline salts are obtained from vegetables; they are sometimes called Lixivial Salts, because most commonly obtained from the Ashes of vegetables by lixiviation & evaporation. The most commodious method of preparing these salts in the large way seems to be that directed by Kunckel in his Ars Vitraria.

Fixed alkaline salts were originally prepared from the Ashes of the plant Kali & from hence

they are supposed to have received their names.
The vegetable fixed Alkalies when pure are constantly the same, whatever subject they have been produced from, & the differences ob:served in these Salts, where there is any, is owing to the manner in which the process has been managed & not upon the qualities of the subject. no art can distinguish the fixed alkaline salts of the sweet plants from those of the bitter or sour; of the purgative from those of the astringent; of the highest cordials & aromatics from those of the most deadly poisons; hence at present they are made chiefly from such subjects as are most plentifull & afford them in greatest purity & in the greatest quantity. They are often ob:tained from Cream or Crystals of Tartar (wh. is an acid & alkali combined, not into a neutral salt because the acid is predominant) by calcin:ation, the action of the fire dissipating the acid & leaving the alkali entire. Pot Ash are obtained from the ashes of different kinds of Wood particularly the hard ones. They are made chiefly in the woody countries Muscovy, Poland, Courland &c. The making of potash has lately engaged the attention

of

of the People of New England, & it has now become a valuable commodity with them. For the process of making Potash see MS:
The common potash generally contains a quantity of a vitriolated Tartar which is scarce acted upon by cold water; hence the alkali may be separated from the neutral salt by dis=-solving in cold water.

The fossil fixed Alkali is a fossil substance obtained from Sea Salt, Borax, & Glauber's Salt. It is likewise sometimes found pure in the eastern parts of the world & was called Natrum by the ancients. Its properties are nearly the same with that of the vegetable fixed alkali, differing only in forming different neutral salts with acids, not deliquiating in the air but rather imparting its moisture thereto, & capable of being crystallized

Volatile Alkalies are artificial productions, generated by the action of the fire or by putrefaction, & not by any known power besides. These salts are generally obtained from animal substances as containing the greatest quantity. Vegetables during putrefaction generate a quantity of a volatile alkaline salt which may likewise be

be obtained from some of them by the action of the fire.

The volatile alkali is obtained from putrid animal substances (especially Urine) by a gentle heat, the alkali being already produced by the act of putrefaction; but from those substances which have not suffered putrefaction no alkali is obtainable without a strong heat, the formation of the alkali when effected by fire alone not taking place till the subject is in a state of ignition. The alkali itself when produced whether by fire or by putrefaction is always of the same volatility, & when compleatly purified their Identity is the same whether obtained from the most acrid, poisonous, or loathsome animals, or the most mild innocent or inoffensive

Both _fixed_ & _volatile_ alkalies are either _mild_ or _caustic_.

Alkalies are rendered caustic by means of Quicklime or strong calcination. Some imagine that the quicklime extricates a gross Earth from the Alkali & in the room thereof substitutes its own more subtile & acrimonious matter. _Dr. Black_ in the physical & literary

essays published by a society at Edinburgh has advanced a new Theory which he has endeavoured to establish by a number of experiments. Fixed Alkalies according to this Gentleman contain a large quantity of fixed air imprisoned in them; the effervescence that arises upon mixing them with acids is no other than a tumultuary discharge of this air. Caustic alkalies he finds make no effervescence with acids, a proof that these alkalies have lost their air; & from the loss of this principle he deduces their causticity. Exposed long to the atmosphere they become saturated with air a fresh, & are now found to be mild again & to effervesce like the plain alkalies. The case is the same with regard to Quicklime. Chalk & other calcarious Earths abound with air & effervesce strongly with acids. By whatever means this air is expelled they become quicklime (which makes no effervescence), & by whatever means their natural quantity of air is restored they return to their natural inactivity. Quiklime absorbs air from fixed alkaline salts; hence in the present process, the

Salt is acuated & the lime rendered inert. When Chalk dissolved in acids, & thus divested of its air, is precipitated by caustic alkalies which have no air to communicate, the precipitate is a true quicklime; whereas when the precipitation is made by plain alkalies the Chalk imbibing their air returns to an indolent earth. — Quicklime in its pure state strongly attracts water & dissolves therein, but after having imbibed a sufficient quantity of air it becomes indissoluble in water as is evident from its separating therefrom on exposure to the air insipid like the crude stone.

Dr. Black likewise found that alkalies lost near half their weight by being deprived of their fixed air or rendered caustic; hence he supposes the increase of weight in some metals by being dissolved in acids & precipitated by alkalies is owing to the fixed air which they imbibe; he likewise supposes the noise produced by means of Aurum fulminans proceeds from a sudden discharge of this air. Those who think so small a quantity of air cannot produce so loud a crack will be pleased to consider that it is not the quantity

of matter but the sudden spring of the particles, provided they all recover their Elasticity at once; that causes so loud a crack.

A knowlege of the nature & properties of fixed Air is of great importance in Philosophy. From a knowlege of this we know the reason why caustic Alkalies do not effervesce with Acids; by it we are led to a true knowlege of the generation & cure of calculi in the human body. For Doct.r Hales has fully proved that the human Calculus contains a great quantity of Air which serves as a bond of cohesion in its particles; hence the operation of all Lithontriptics or solvents of the Stone is by extricating this air, as Limewater Soap &c: The lime in the water being deprived of its fixed air may perhaps pass through the body until it comes in contact with the stone from which it may absorb the fixed air until it becomes saturated. The caustic alkali in the Soap is rendered capable of being recieved into the body by being combined with the oil, & entering the Bladder may perhaps be decompounded by the Urine when the alkali, being in its caustic state, will act powerfully on the stone. By knowing that fixed air is the cement or

or bond of union in the constituent parts of bodies we are led to a knowlege of the true cause of cohesion therein. Most philosophers have supposed that the attraction of cohesion was the sole cause of the solidity of bodies; if so all nature would then run into one coherent mass. The flying off of this fixed Air into an elastic state causes an intestine motion in the particles of the body, & if a sufficient quantity of water be united therewith so as to render the body fluid, a change of combination will take place. — How fixed air can pass from a non repellant & non elastic to a repellant & elastic state & vice versa is not easily conceived; but from undoubted experiments we are as certain of it as that we breathe. The nature of this fixed air as well as that of elective Attraction was not unknown to that truly comprehensive genius Sir Isaac Newton; & it was by pursuing the hints given by this great man that Dr. Hales prosecuted his enquiries & found by undeniable experiments that air was the cause of cohesion in all bodies whether vegetable or animal. Haller likewise says that air is the vinculum or bond of union in the particles of all bodies. Fixed air may be

transferred from a body in which it is, into a body deprived of it, as is evident from the curious & decisive experiment of Mr. Bride.

Alkalies considered in their relation to other bodies.

1.st Saline. They unite with acids, if in a mild state with effervescence, but if in a caustic state without, & produce different neutral salts according to the nature of the acid & alkali employed. Fixed Alkalies readily crystallize with any of the mineral acids & with Tartar, wth. which last they compose a neutral Salt much easier of solution than the Tartar itself, & hence called soluble Tartar. They do not easily crystallize with the acid of Vinegar or Lemon Juice; their mixtures if by careful management reduced to a crystalline form soon deliquiate in the air again. The volatile alkalies form with acids semivolatile concretes called ammoniacal salts which readily crystallize on due evaporation.

2.d Inflammable. Alkalies unite with oils in a caustic state forming Soap, with Sulphur forming Hepar Sulphuris; added to Ardent Spirits they absorb the phlegmatic part & thus render them

them more concentrated. Volatile alkalies with ardent Spirits form a coagulum. They extract the odoriferous particles of essential oils & thence form the Sal volatile oleosum.

3.^d Metallic. Alkaline Salts render metals fusible, & in a caustic state act powerfully on the calces of metals. Hepar Sulphuris may be made to unite with all metals even Gold & Silver.

4.^th Earthy. Some earths are rendered vitrifiable by means of alkalies.

5.^th Watery. Alkalies are soluble in water; they heighten the colour of animal & vegetable tinctures whether drawn with water or spirits, but they commonly vary the taste & often debase the smell of the preparation. They dissolve animal & vegetable concretions & from thence depends the art of Bleaching. They check fermentation.

Their Names. Alkaline Salts have recieved various names from the different bodies from which they are obtained, & the different methods of obtaining them.